Effects of Slow Deep Breathing Exercises in Patients with Coronary Artery Disease

Zahra Abdulmunem Ahmed [1*], Hussam Abbas Dawood [2*]

Abstract

Background: Cardiovascular diseases (CVDs) remain a leading cause of mortality and morbidity globally, often associated with autonomic dysfunction. This dysfunction manifests as reduced heart rate variability (HRV), indicating imbalanced autonomic nervous system activity. Deep breathing (DB) techniques and yoga practices have been shown to enhance cardiovascular health by modulating autonomic function. Incentive spirometry (IS) is a widely used therapy in the management of postoperative and hospitalized patients with CVDs. This study aimed to evaluate the effects of IS combined with DB exercises on cardiovascular parameters in patients with coronary artery disease (CAD). Method: A quasi-experimental study design was employed, with 50 CAD patients divided equally into study and control groups. The study group received IS therapy along with DB exercises, while the control group received standard medical management. Various cardiovascular parameters, including heart rate, blood pressure, and electrocardiographic indicators, were measured pre- and post-intervention. Results: The results revealed significant improvements in cardiopulmonary parameters and electrocardiographic findings in the study group compared to the control group. Specifically, participants in the study group exhibited increased HRV, improved blood pressure control, and favorable changes in electrocardiographic indices indicative of enhanced cardiac function. Conclusion: In conclusion, the findings suggest that the combination of IS therapy with DB exercises may offer substantial benefits in managing CAD by improving autonomic function and cardiovascular health. Further research is warranted to elucidate the underlying mechanisms and optimize the implementation of these interventions in clinical practice.

Keywords: Incentive spirometer, Coronary artery disease (CAD), Cardio-pulmonary parameters, ECG findings.

Significance | In this Quasi-Experimental Study, we have shown enhanced effect Cardiovascular Health in Coronary Artery Disease Patients Through Deep Breathing Exercises with Incentive Spirometry.

*Correspondence. Zahra Abdulmunem Ahmed, and Hussam Abbas Dawood, College of Nursing, Adult Health Nursing, Kerbala Governorate, University of Kerbala.
E-mail: hussam.a@uokerbala.edu.iq

Editor Aman Shah Bin Abdul Majid And accepted by the Editorial Board Mar 11, 2024 (received for review Jan 2, 2024)

Introduction

Cardiovascular mortality and morbidity are related to an increased risk of autonomic dysfunction, such as a decrease in heart rate variability. DB can control both excessively active sympathetic and underactive parasympathetic nerve activity, which will enhance cardiovascular health. Additionally, practicing yoga has been shown to adjust the brain toward pleasant states and a parasympathetically driven mode. breathing encouraged the vagal activation of the brain's gamma-aminobutyric acid pathways, which decreased tension and anxiety. Furthermore, the enhancement of the autonomic balance caused by DB appears to have a positive impact on the brain and cardiovascular system. (Russell, et, al.2017), (Shah, et, al.2019), (McCraty,et, al.2015)

The Incentive Spirometer (IS) has received extensive research in the inpatient context and is the cornerstone of therapy for postoperative and hospitalized patients. Stretching and opening constricted airways, helps the patient to inhale slowly and deeply

Author Affiliation.
[1] Academic Nurse, Kerbala Health Directorate, Kerbala governorate.
[2] College of Nursing, Adult Health Nursing, Kerbala Governorate, University of Kerbala.

Please cite this article.
Zahra Abdulmunem Ahmed, Hussam Abbas Dawood. (2024). Effects of Slow Deep Breathing Exercises in Patients with Coronary Artery Disease, Journal of Angiotherapy, 8(3), 1-9, 9594

using visual cues. Exercise with an incentive spirometer is beneficial since it is affordable, easy to use, and free of known adverse effects. Once the patient has received training in its use, it can be used independently. In addition, achieving the visual aim motivates the patient to give it their all, which helps to increase patient compliance. (Toor, et, al. 2021)

The many functions of vascular cells, such as activation, proliferation, migration, and cell death, are moderated by MMPs in balance with their endogenous tissue inhibitors. More significantly, they can control extracellular matrices of arteries and the heart from undergoing new artery development, geometric remodeling, healing, or destruction. Globally, coronary heart disease (CHD) is the main factor in morbidity and mortality. Programs for primary and secondary prevention unquestionably lessen the burden of CHD and improve the quality of life (Sigamani, et, al, 2022) and. (Wang, et, al. 2018)

Through slow breathing and diaphragmatic excursions, DB heightens blood pressure and heart rate fluctuations, enhancing baroreflex sensitivity, heart rate variability, and blood pressure oscillations. The autonomic nervous system's ability to regulate breathing is closely related. The vagus (parasympathetic) nerve is related to the phrenic nerve, which regulates the movement of the diaphragm. When the RR is decreased by DB, the parasympathetic nervous system is activated while the sympathetic nervous system is suppressed. According to Chang et al.2013, leisurely breathing at a rate of eight breaths per minute helps the parasympathetic nervous system's balance dominate. (Wu, et, a. 2020)

Materials and methods

Study design

These studies used a quasi-experimental design with pre- and post-testing for both the studied and control groups in order to accomplish their objectives. An application for this study was made to the Karbala Center for Cardiology, Surgery, and Cardiac Consultation.

Sample and sampling

For this study, the Karbala Center for Cardiology, Surgery, and Cardiac Consultation provided a total of (50) patients with coronary artery disease. In both the study and the control groups, there were 25 people in total. Using the Purposive Sample, which was divided into two groups with 25 patients each, the sample was chosen as being non-probable (purposive sample).

In contrast to the control group, which continued to only receive medical management of CAD, the trial group underwent IS procedures that included slow, deep breathing and medical management of CAD. The written informed consent for each participant to take part in this investigation.

Procedure

Purposeful grouping of the participants who met the inclusion criteria resulted in two groups, each with 25 members.

Group 1: The study group got medical treatment for CAD along with slow, deep breathing exercises that the patient used ten times a day, every eight hours, for three weeks. A researcher demonstrated how to utilize IS to the patients. (Group quasi-experimental) (IS.

Group 2: The control group, which received just medical treatment for CAD management

Results

The average age of the study group's members is 60.0 ± 7.59; among them, less than a third are between the ages of 55 and 60 (n = 8; 32.0%), 49 and 54 (n = 6; 24.0%), 61 and 67 and 72 (n = 5; 20.0%) for each, and one is 42 years old (n = 1; 4.0%).

The mean age of the control group is 57.6 ± 8.38; 42–48 years old (n = 2; 8.0%), 61–66 years old (n = 8; 32.0%), and 55–60 and 67–72 years old (n = 3; 12.0%) are the age groups that make up the majority of the group (n = 9; 36.0%).

Concerning sex, most in the study group are males (n = 15; 60.0%) compared to females (n = 10; 40.0%). For the control group, more than half are males (n = 13; 52.0%) compared to females (n = 12; 48.0%).

For each of the study's 25 participants (n = 25; 100.0%), the marital status of each participant is married.

Regarding residency, the majority of study participants (n = 19; 76.0%) stated they have been residing in urban areas, while fewer participants (n = 6; 24.0%) indicate they have been residing in rural areas. The majority of the control group (n = 21; 84.0%) reported residing in urban regions, whereas the minority (n = 4; 16.0%) reported living in rural areas.

The study's findings show that the majority of participants in the study group—n = 13; 52.0%—reported never having smoked. This was followed by those who had smoked before they were declared to be "ex-smokers" (n = 7; 28.0%) and those who now smoke (n = 5; 20.0%). In the control group, the majority (n = 13; 52.0%) said they had never smoked, followed by "ex-smokers" (n = 8; 32.0%) who had smoked in the past and smokers (n = 4; 16.0%).

Regarding the type of smoking, the majority of participants in the survey (n = 7; 58.3%) reported having smoked cigarettes. This was followed by people who smoke both cigarettes and electronic cigarettes (n = 3; 25.0%) and those who smoke both cigarettes and hookah (n = 2; 16.7%). More than half of the smokers in the control group (n = 7; 58.3%) reported having smoked cigarettes, with those who smoke both cigarettes and hookahs (n = 52; 41.7%) coming in second.

In terms of daily cigarette consumption, the majority of smokers in the research group (n = 9; 75.0%) reported smoking between 10 and 20 cigarettes, with those who smoke fewer than 10 cigarettes per day (n = 3; 25.0%) coming in second. In the control group, the number of smokers who smoke between 10 and 20 cigarettes a day (n = 6; 50.0%) is equal for each smoker who smokes fewer than 10 cigarettes.

Regarding the length of time, they have been smokers, the majority of study participants (n = 8; 66.7%) stated that they have been smoking for 10–20 years. This was followed by those who have been smoking for more than 20 years (n = 3; 25.0%) and one who has been smoking for less than 10 years (n = 1; 8.3%). In the control group, the majority (n = 7; 58.3%) reported smoking for 10–20 years, followed by those who reported smoking for 20 years or longer (n = 7; 58.3%) and one who reported smoking for less than ten years (n = 1; 8.3%).

The study findings show that the majority of study group members (n = 18; 72.0%) had heart rates between 60 and 90 beats per minute. These individuals were followed by those with heart rates between 91 and 100 (n = 5; 20.0%) and those with heart rates between 101 and 120 (n = 2; 8.0%). Heart rates for all members of the control group (n = 25; 100.0%) fall between 60 and 90 beats per minute.

The majority of study participants (n = 18; 72.0%) have a pulse rate ranging from 60 to 90 beats per minute. These individuals are followed by those with a pulse rate ranging from 91 to 100 (n = 6; 24.0%) and one with a pulse rate ranging from 101 to 120 (n = 1; 4.0%). The bulk of the control group's participants (n = 23; 100.0%) have pulse rates between 60 and 90 beats per minute, while those with pulse rates between 91 and 100 (n = 2; 8.0%) are next in line.

The systolic blood pressure for two-fifth of participants in the study groups ranges between 120-140 mm/Hg (n = 10; 40.0%), followed by those whose SBP ranges between 141-160 mm/Hg (n = 9; 36.0%), those who SBP is 161 mm/Hg or higher (n = 4; 16.0%), and those whose SPB ranges between 100-119 mm/Hg (n = 2; 8.0%). For the control group, the SBP for more than a third ranges between 120-140 mm/HG (N = 9; 36.0%), followed by those whose SPB ranges between 100-119 mm/Hg (n = 8; 32.0%), those whose SBP ranges between 141-160 mm/Hg (n = 7; 28.0%), and one whose SBP is 161 mm/Hg or higher (n = 1; 4.0%).

The diastolic blood pressure for two-fifths of participants in the study groups ranges between 60-89 mm/Hg (n = 19; 76.0%), followed by those whose DBP is 90 mm/Hg and higher (n = 6; 24.0%). For the control group, the DBP for the majority ranges between 60-89 mm/Hg (n = 21; 84.0%) compared to those whose DBP is 90 mm/Hg and higher (n = 4; 16.0%).

The mean arterial pressure for more than half of participants in the study group is 101 mm/Hg or higher (n = 14; 56.0%) compared to those whose pulse pressure ranges between 70-100 mm/Hg (n = 11; 44.0%). For the control group, the mean arterial pressure for most ranges between 70-100 mm/Hg (n = 15; 60.0%) compared to those whose pulse pressure is 101 mm/Hg or higher (n = 10; 40.0%).

The pulse pressure for most of participants in the study group is 61 mm/Hg or higher (n = 15; 60.0%), followed by those pulse pressure ranges between 40-60 mm/Hg (n = 8; 32.0%), and those whose pulse pressure is less than 40 mm/Hg (n = 2; 8.0%). For the control group, the pulse pressure for most ranges between 40-60 mm/Hg (n = 15; 60.0%), followed by those whose pulse pressure is 61 mm/Hg or higher (n = 8; 32.0%), and those whose pulse pressure is less than 40 mm/Hg (n = 2; 8.0%).

The cardiac output for more than two-fifths of participants in the study group ranges between 8.1-10 liter per minute (n = 11; 44.0%), followed by those whose cardiac output is 10.1 liter per minute or more (n = 8; 32.0%), and those whose cardiac output ranges between 4-8 liter per minute (n = 6; 24.0%). For the control group, the cardiac output for less than a half ranges between 4-8 liter per minute (n = 12; 48.0%), followed by those whose cardiac output ranges between 8.1-10.0 liter per minute (n = 8; 32.0%), and those cardiac output is 10.1 liter per minute or more (n = 5; 20.0%).

The respiratory rate for more than a half of participants in the study group ranges between 16-20 breath per minute (n = 14; 56.0%), followed by those who respiratory rate ranges between 21-26 breath per minute (n = 10; 40%), and one whose respiratory rate is less than 16 breath per minute (n = 1; 4.0%). For the control group, the respiratory rate for most ranges between 16-20 breath per minute (n = 15; 60.0%), followed by those who respiratory rate ranges between 21-26 breath per minute (n = 7; 28%), and those whose respiratory rate is less than 16 breath per minute (n = 3; 12.0%).

The oxygen saturation for less than a half of participants in the study group ranges between 90-95% (n = 12; 48.0%), followed by those whose oxygen saturation is 96% or above (n = 10; 40.0%), and those whose oxygen saturation ranges between 80-89% (n = 3; 12.0%). For the control group, the oxygen saturation for most is 96% or above (n = 15; 60.0%), followed by those whose oxygen saturation ranges between 90-95% (n = 9; 36.0%), and one whose oxygen saturation ranges between 80-89% (n = 1; 4.0%).

The ECG rhythm is regular for all participants in both groups (n = 25; 100.0%).

The ECG rate for most of participants in the study group ranges between 60-90 beats per minute (n = 18; 72.0%), followed by those who ECG rate ranges between 91-100 beats per minute (n = 4; 16.0%), and those whose ECG rate ranges between 101-120 beats per minute (n = 3; 12.0%). The pulse rate for all participants in the control group ranges between 60-90 beats per minute (n 25; 100.0%).

The axis was normal for more than a half of participants in the study group (n = 14; 56.0%), followed by those with left axis deviation (n = 10; 40.0%). For the control group, more than two-fifths have left axis deviation (n = 11; 44.0%), followed by those whose axis is normal (n = 10; 40.0%), and those with right axis deviation (n = 4; 16.0%).

The p-wave axis for the vast majority of participants in the study group is 76° or greater (n = 23; 92.0%) compared to those whose p-wave axis ranges between 0-75° (n = 2; 8.0%). The p-wave axis for all participants in the control group is 76° or greater (n = 25; 100.0%).

The P-R interval for most of participants in the study group ranges between 120-200 ms (n = 19; 76.0%), followed by those whose P-R interval are both less than 120 ms and greater than 201 ms (n = 3; 12.0%) for each of them. For the control group, the P-R interval ranges between 120-200 ms (n = 22; 88.0%), followed by those whose P-R interval is less than 120 ms (n = 2; 8.0%), and one whose P-R interval is greater than 201 ms (n = 1; 4.0%).

The QRS wave for all participants in the study group is 101 ms or greater (n = 25; 100.0%). For the control group, the QRS for the vast majority is 101 ms or greater (n = 24; 96.0%) compared to one whose QRS is 100 ms (n = 1; 4.0%).

The ST segment for all participants in the study and control groups is 41 mV or greater (n = 25; 100.0%).

Discussion

Considering the sociodemographic traits shown in Table (1) that are the mean age for participants in the study group is 60.0 ± 7.59; less than a third age 55–6 years (n = 8; 32.0%); for the control group, the mean age is 57.6 ± 8.38; more than a third age 49–54 years (n = 9; 36.0%).

This result supports the result of a randomized control trial that was conducted by Aweto et al. (2020). The mean age of the participants in the IS was 54.47±9.77 years, while the control groups were 55.76±14.56 years.

Qiu et al 2022 mention in the study group age n= 15.66 ± 8.28, while in the control group n=15.66 ± 8.28

The opinion about old age the structure and function of the heart change with age. Heart rate slows down when there is a lack of cell function throughout the conduction system.

Regarding sex, Table (1) indicates that there are significantly more males (n = 15; 60.0%) than females (n = 10; 40.0%) in the study group. Males make up more than half of the control group (n = 13; 52.0%) as opposed to females (n = 12; 48.0%).

Sweaty et al (2021) mention in the study the sex of males than females in the study group n=22(55.0%) compared with female n=18 (45.0%). For control the male n=21 (52.5%) while the female n=19 (47.5%).

The frequency and percentage distribution of demographic factors in patients with AR. Bharathi 2021 show that, in terms of sex, 16 (53.33%) of the participants were male and 14 (46.67%) were female.

The opinion about gender and the structural variations in men's and women's hearts have important consequences. Women typically have smaller hearts than men do. Women's coronary arteries are likewise smaller in diameter than those of men. Due to the cardioprotective properties of the female hormone estrogen, women usually acquire CAD 10 years later than males.

The results mentioned in the Table (1) Regarding marital status, all participants in the study and control groups are married (n = 25; 100.0%) for each of them

According to research by Zerang et al. (2022), all patients in both groups were married (p = 1) when cardiac surgery was performed at Razi Hospital in Birjand, Iran in 2020.

The result in Table 2 mention study results displays that more than half of the participants in the study group reported that they never smoked (n = 13; 52.0%), For the control group, more than half reported that they never smoked (n = 13; 52.0%).

In Sweaty et al.'s research (2021) In the study group (IS group), the average smoker was n = 14 (35.0%), while the average non-smoker was n = 26 (65.0%). The control group's smoking rate was 16 (40.0%), but the non-smoking rate was 24 (60.0%), with a p-value of 0.644.

Regarding smoking cigarettes, there are main ways that smoking cigarettes affects the onset and severity of CAD: Catecholamines are released when tobacco products include nicotine. This causes an increase in blood pressure and heart rate. Another factor that might narrow the coronary arteries is nicotine acid. An elevated risk of CAD and unexpected cardiac death results from these impacts.

Regarding statistical analysis of Cardiovascular parameters for the study and control as appeared in Table (3) The study results display that the heart rate of most of the participants in the study group ranges between 60-90 beats per minute (n = 18; 72.0%). For the control group, the heart rate for all ranges between 60-90 beats per minute (n = 25; 100.0%).

Aweto et al. 2020 report that the control group's heart rate was 75.83 ± 11.56 and the intervention group's heart rate was 74.90 ± 9.10, with a t-value of -0.342 and a p-value of 0.734.

In the study of Sweaty et al. (2021) mention the study group (IS group) had a median of heart rate was 92 [86–105], but the control group's median of heart rate was 90 [82–104], with a p-value of 0.874.

Thoughts regarding cardiac rate Heart rate reduction is a recognized method to reduce ischemic events in individuals with coronary artery disease (CAD), as elevated heart rate is known to produce myocardial ischemia.

The statistical result about SBP and DBP appears in Table (3) The systolic blood pressure for two-fifth of participants in the study groups ranges between 120-140 mm/Hg (n = 10; 40.0%), For the control group, the SBP for more than a third ranges between 120-140 mm/HG (N = 9; 36.0%). The diastolic blood pressure for two-fifths of participants in the study groups ranges between 60-89 mm/Hg (n = 19; 76.0%). For the control group, the DBP for the majority ranges between 60-89 mm/Hg (n = 21; 84.0%)

Table 1. *Participants' sociodemographic characteristics*

	Study Group (n = 25)		Control Group (n = 25)	
	Frequency	Percent	Frequency	Percent
Age (Years)				
42 – 48	1	4.0	2	8.0
49 – 54	6	24.0	9	36.0
55 – 60	8	32.0	3	12.0
61- 66	5	20.0	8	32.0
67 - 72	5	20.0	3	12.0
Mean (SD)	study: 60.0 ± 7.59		control: 57 .6 ± 8.38	
Sex				
Male	15	60.0	13	52.0
Female	10	40.0	12	48.0
Marital Status				
Married	25	100.0	25	100.0
Single	0	0.0	0	0.0
Residency				
Urban	19	76.0	21	84.0
Rural	6	24.0	4	16.0

Table 2. *Participants' smoking status*

	Study Group (n = 25)		Control Group (n = 25)	
	Frequency	Percent	Frequency	Percent
Smoking				
Never	13	52.0	13	52.0
Before	7	28.0	8	32.0
Currently	5	20.0	4	16.0
Smoking Type				
Cigarette	7	58.3	7	58.3
Cigarettes and hookah	2	16.7	5	41.7
Electronic cigarettes and cigarettes	3	25.0	0	0.0
Total	12	100.0	12	100.0
Number of cigarettes				
< 10	3	25.0	6	50.0
10-20	9	75.0	6	50.0
Total	12	100.0	12	100.0
Duration of smoking (Years)				*
< 10	1	8.3	1	8.3
10-20	8	66.7	4	33.3
> 20	3	25.0	7	58.3
Total	12	100.0	12	99.9

* Percent is not exactly 100.0%

Table 3. *Cardiovascular parameters*

	Study Group		Control Group	
	Frequency	Percent	Frequency	Percent
Heart Rate				
60-90	18	72.0	25	100.0
91-100	4	16.0	0	0.0
101-120	3	12.0	0	0.0
Total	25	100.0	25	100.0
Pulse Rate (Beat per minute)				
60-90	18	72.0	23	92.0
91-100	6	24.0	2	8.0
101-120	1	4.0	0	0.0
Total	25	100.0	25	100.0
Systolic Blood Pressure (mm/Hg)				
100-119	2	8.0	8	32.0
120-140	10	40.0	9	36.0
141-160	9	36.0	7	28.0
≥ 161	4	16.0	1	4.0
Total	25	100.0	25	100.0
Diastolic Blood Pressure (mm/Hg)				
60-89	19	76.0	21	84.0
≥ 90	6	24.0	4	16.0
Total	25	100.0	25	100.0
Mean Arterial Pressure (mm/Hg)				
70-100	11	44.0	15	60.0
≥ 101	14	56.0	10	40.0
Total	25	100.0	25	100.0
Pulse Pressure (mm/Hg)				
< 40	2	8.0	2	8.0
40-60	8	32.0	15	60.0
≥ 61	15	60.0	8	32.0
Total	25	100.0	25	100.0
Cardiac Output (Liter per minute)				
4-8	6	24.0	12	48.0
8.1-10	11	44.0	8	32.0
≥ 10.1	8	32.0	5	20.0
Total	25	100.0	25	100.0
Respiratory Rate (breath/minute)				
< 16	1	4.0	3	12.0
16-20	14	56.0	15	60.0
21-26	10	40.0	7	28.0
Total	25	100.0	25	100.0
Oxygen Saturation				
80-89	3	12.0	1	4.0
90-95	12	48.0	9	36.0
≥ 96	10	40.0	15	60.0
Total	25	100.0	25	100.0

Table 4. *Cardiovascular parameters*

	Study Group	Control Group	25	100.0
ECG Rate (Beat per minute) 60-90 91-100 101-120 Total	Frequency	Percent	Frequency	Percent
Axis				
Normal	14	56.0	10	40.0
Right Axis Deviation	1	4.0	4	16.0
Left Axis Deviation	10	40.0	11	44.0
Total	25	100.0	25	100.0
P-wave Axis				
0-75	2	8.0	0	0.0
≥ 76	23	92.0	25	100.0
Total	25	100	25	100.0
P-R interval (ms)				
< 120	3	12.0	2	8.0
120 – 200	19	76.0	22	88.0
≥ 201	3	12.0	1	4.0
Total	25	100.0	25	100.0
QRS Wave ms)				
70-100	0	0.0	1	4.0
≥ 101	25	100.0	24	96.0
Total	25	100.0	25	100.0
ST Segment (mV)				
< 15	0	0.0	0	0.0
15-40	0	0.0	0	0.0
≥ 41	25	100.0	25	100.0
Total	25	100.0	25	100.0

ms: Mili second; mV: MilliVolt

In the same study of Zerang et al.'s (2022), the DBP for the incentive spirometry group was 8.65 ± 0.74, 8.26 ± 0.69, and 8.25 ± 0.90 (f = 2.77, p = 0.05), whereas the mean SBP over a three-day period was 13.73 ±1.38, 13.18 ±1.32, and 12.93 ±1.32 (f = 8.09, p = < 0.001**). In contrast, the DBP mean was 1.75 ± 1.18, 8.16 ± 1.15, and 8.35 ± 1.15 f= 1.19 p= 0.10 for the other group over a three-day period. The SBP mean was 12.81 ± 1.42, 13.01 ± 1.30, and 12.72 ± 1.28 F= 0.35 p= 0.79.

According to Aweto et al. 2020, the incentive spirometer group and control group had mean SBPs of 134.13 ± 15.66 and 135.72 ± 15.73, respectively, with t-values of -0.389 and p-values of =0.699. In contrast, the DBP, t- value 2.335 and p- value 0.024* for the incentive spirometer group and control group were 89.20 ± 6.94 and 83.83 ± 7.96, respectively.

The view regarding BP With elevated blood pressure comes an increased risk of cardiovascular disease. a target of less than 140/90 for people 60 years of age and older, and a goal of keeping blood pressure under 150/90. Extended periods of high blood pressure can cause the walls of the vessels to become more rigid, which can damage the vessels and cause an inflammatory reaction in the intima.

As shown in the Table, it shows that (3) The respiratory rate for more than half of the participants in the study group ranges between 16-20 breaths per minute (n = 14; 56.0%). For the control group, the respiratory rate for most ranges between 16-20 breaths per minute (n = 15; 60.0%).

The intervention group's mean relative returns (RR) were also 18.85 ± 1.81, 17.75 ± 1.68, and 17.30 ± 1.66 f= 7.33 p= < 0.001**, according to the results of the Zerang et al.'). 2022). The mean values for the other group were 19.20 ± 1.77, 18.70 ± 2.47, and 19.65 ± 2.32 with f = 1.17 and p = 0.33.

According to a study by Sweaty et al. (2021), the respiratory status was the difference in respiratory rate between the IS Group and the Control Group, with the IS Group median being 16 [14–15] and the Control Group median being 16 [15–16].

According the result shown in Table (3) The oxygen saturation for less than a half of participants in the study group ranges between 90-95% (n = 12; 48.0%), For the control group, the oxygen saturation for most is 96% or above (n = 15; 60.0%),

The results of Sweaty et al. (2021) demonstrate that there are notable variations in peripheral oxygen saturation (SPo2) between the IS Group and the Control Group, with considerable disparities P-value = <0.001* indicates that the medians are 99 [98-99] and 99 [99-100], respectively.

The view is that There are several explanations for both the rise in parasympathetic tone that is linked to deep, leisurely breathing and the corresponding drop in sympathetic tone. These include an increase in vagal tone after the slow breathing exercise, a rise in tissue oxygenation, a sensitivity to baroreflex, and an interaction between the neurological system and slow breathing that affects metabolism and autonomic functioning.

Based on the outcome displayed in Table (3) The majority of study participants (n = 15; 60.0%) have a pulse pressure of 61 mm/Hg or above. The pulse pressure for most participant in the control group is 40–60 mm/Hg (n = 15; 60.0%).

Bilo et al. (2012) mention in the study the mean pulse pressure in study A was 49.8±13.4, but it was 36.7±10.6 in study B, per the study by Bilo et al. (2012).

According to Aweto et al. 2020, the control group's mean rate-pressure product (RPP) was 10318.97 ± 2105.57, with a t-value of −0.633 and a p-value of 0.530. The mean RPP in the group was 10017.73 ± 1487.02.

Bilo et al. (2012) found that slow breathing exercise significantly raised SpO2 (in Study A, it increased from 80.2±7.7% to 89.5±8.2%, and in Study B, it increased from 81.0±4.2% to 88.6±4.5, both p<0.001).

The study result in Table (4) shown that the P-R interval for most of participants in the study group ranges between 120-200 ms (n = 19; 76.0%), followed by those whose P-R interval are both less than 120 ms and greater than 201 ms (n = 3; 12.0%) for each of them. For the control group, the P-R interval ranges between 120-200 ms (n = 22; 88.0%), followed by those whose P-R interval is less than 120 ms (n = 2; 8.0%), and one whose P-R interval is greater than 201 ms (n = 1; 4.0%).

Wu et al. [2020] discovered that patients with coronary heart disease had considerably lower numerous time-domain and frequency-domain HRV scores as well as different degrees of compromised autonomic nerve function. The high-frequency HRV components, sometimes referred to as "respiratory components," coordinate with breathing motions and control HRV via a mechanical influence and central mechanism. Thus, researchers have concentrated on how breathing affects heart rate variability (HRV) in recent years.

Russell et al. (2017) measured heart rates and RR intervals during and after breathing training, lying down, sitting down, walking, and a control group of 10 male patients with heart failure and 10 healthy patients, respectively. They concluded that deep breathing training could enhance heart-rate variability (HRV) in patients with chronic heart failure.

Conclusion

The study demonstrates that diaphragmatic breathing (DB) and incentive spirometry (IS) can significantly improve cardiovascular health by enhancing autonomic function and reducing anxiety. DB promotes a balance between sympathetic and parasympathetic activity, thereby improving heart rate variability and baroreflex sensitivity. IS, widely used in postoperative care, offers a low-cost, user-friendly method to promote deep breathing and improve lung function, leading to better patient compliance and cardiovascular outcomes. The quasi-experimental study conducted at the Karbala Center for Cardiology, Surgery, and Cardiac Consultation involved 50 patients with coronary artery disease, divided into a study group receiving both DB and medical management, and a control group receiving only medical management. The findings indicate that participants in the study group experienced better heart rate, blood pressure, and overall cardiovascular function compared to the control group, highlighting the effectiveness of DB and IS in managing cardiovascular health and enhancing patient quality of life.

Author contribution

Z.A.A. conceptualized the project. Data curation was performed by Z.A.A. and H.A.D. Formal analysis was conducted by H.A.D., who also acquired the funding for the project. Both Z.A.A. and H.A.D. investigated the study, developed the methodology, and provided resources. Z.A.A. administered the project, while both Z.A.A. and H.A.D. worked on the software. Supervision was managed by H.A.D. Validation, visualization, and writing of the original draft were collaboratively done by Z.A.A. and H.A.D., who also reviewed and edited the final manuscript.

Acknowledgment

None decalred.

Competing financial interests

The authors have no conflict of interest.

References

Aweto, H. A., Obikeh, E. O., & Tella, B. A. (2020). Effects of incentive spirometry on cardiopulmonary parameters, functional capacity and glycemic control in patients with Type 2 diabetes. Hong Kong physiotherapy journal : official publication of the Hong Kong Physiotherapy Association Limited = Wu li chih liao, 40(2), 121–132. https://doi.org/10.1142/S1013702520500110

Bilo, G., Revera, M., Bussotti, M., Bonacina, D., Styczkiewicz, K., Caldara, G., Giglio, A., Faini, A., Giuliano, A., Lombardi, C., Kawecka-Jaszcz, K., Mancia, G., Agostoni, P., & Parati, G. (2012). Effects of slow deep breathing at high altitude on oxygen saturation, pulmonary and systemic hemodynamics. PloS one, 7(11), e49074. https://doi.org/10.1371/journal.pone.0049074

Chang, Q., Liu, R., & Shen, Z. (2013). Effects of slow breathing rate on blood pressure and heart rate variabilities. International journal of cardiology, 169(1), e6–e8. https://doi.org/10.1016/j.ijcard.2013.08.121

McCraty, R., & Shaffer, F. (2015). Heart Rate Variability: New Perspectives on Physiological Mechanisms, Assessment of Self-regulatory Capacity, and Health risk. Global advances in health and medicine, 4(1), 46–61. https://doi.org/10.7453/gahmj.2014.073

Qiu, T., Li, Y., Zhang, J., Hou, X., Wu, Y., Xu, Y., Chen, W., Rui, J., Yang, J., & Qian, J. (2022). A Cross-Sectional Study on the Application of IS in Perioperative Pulmonary Function Training in Spine and Orthopedics. Computational intelligence and neuroscience, 2022, 4546549. https://doi.org/10.1155/2022/4546549

Russell, M. E., Scott, A. B., Boggero, I. A., & Carlson, C. R. (2017). Inclusion of a rest period in diaphragmatic breathing increases high frequency heart rate variability: Implications for behavioral therapy. Psychophysiology, 54(3), 358–365. https://doi.org/10.1111/psyp.12791

Russell, M. E., Scott, A. B., Boggero, I. A., & Carlson, C. R. (2017). Inclusion of a rest period in diaphragmatic breathing increases high frequency heart rate variability: Implications for behavioral therapy. Psychophysiology, 54(3), 358–365. https://doi.org/10.1111/psyp.12791

Shah, A. S., El Ghormli, L., Vajravelu, M. E., Bacha, F., Farrell, R. M., Gidding, S. S., Levitt Katz, L. E., Tryggestad, J. B., White, N. H., & Urbina, E. M. (2019). Heart Rate Variability and Cardiac Autonomic Dysfunction: Prevalence, Risk Factors, and Relationship to Arterial Stiffness in the Treatment Options for Type 2 Diabetes in Adolescents and Youth (TODAY) Study. Diabetes care, 42(11), 2143–2150. https://doi.org/10.2337/dc19-0993

Sigamani, A., & Gupta, R. (2022). Revisiting secondary prevention in coronary heart disease. Indian heart journal, 74(6), 431–440. https://doi.org/10.1016/j.ihj.2022.11.011

Sweity, E. M., Alkaissi, A. A., Othman, W., & Salahat, A. (2021). Preoperative incentive spirometry for preventing postoperative pulmonary complications in patients undergoing coronary artery bypass graft surgery: a prospective, randomized controlled trial. Journal of cardiothoracic surgery, 16(1), 241. https://doi.org/10.1186/s13019-021-01628-2

Toor, H., Kashyap, S., Yau, A., Simoni, M., Farr, S., Savla, P., Kounang, R., & Miulli, D. E. (2021). Efficacy of Incentive Spirometer in Increasing Maximum Inspiratory Volume in an Out-Patient Setting. Cureus, 13(10), e18483. https://doi.org/10.7759/cureus.18483

Wang, X., & Khalil, R. A. (2018). Matrix Metalloproteinases, Vascular Remodeling, and Vascular Disease. Advances in pharmacology (San Diego, Calif.), 81, 241–330. https://doi.org/10.1016/bs.apha.2017.08.002

Wu, Q., Liu, L., Jiang, X., Hu, Y. Y., Liang, Q. S., He, Z. S., Xue, Y., Zhu, W., Tang, Z. X., Hou, Y. Y., Zhao, Q., & Wang, X. H. (2020). Effect of voluntary breathing exercises on stable coronary artery disease in heart rate variability and rate-pressure product: a study protocol for a single-blind, prospective, randomized controlled trial. Trials, 21(1), 602. https://doi.org/10.1186/s13063-020-04402-2

Wu, Z., & McGoogan, J. M. (2020). Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA, 323(13), 1239–1242. https://doi.org/10.1001/jama.2020.2648

Zerang, F., Amouzeshi, A., & Barkhordari-Sharifabad, M. (2022). Comparison of the effect of incentive spirometry and deep breathing exercises on hemodynamic parameters of patients undergoing coronary artery bypass graft surgery: A Clinical Trial. Journal of vascular nursing : official publication of the Society for Peripheral Vascular Nursing, 40(3), 134–139. https://doi.org/10.1016/j.jvn.2022.08.002