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EFFECTS OF DEEP BREATHING TRAINING ON EXERCISE-INDUCED CHANGES OF CARDIOVASCULAR PARAMETERS IN NORMAL YOUNG VOLUNTEERS.

Dissertation submitted in partial fulfillment for the Degree of Bachelor of Science (Health) in Biomedicine

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CERTIFICATE

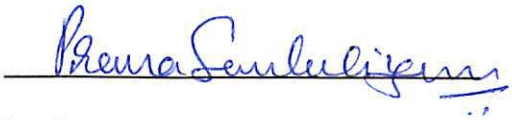
This is to certify that dissertation entitled

"EFFECTS OF DEEP BREATHING TRAINING ON EXERCISE-INDUCED CHANGES OF CARDIOVASCULAR PARAMETERS IN NORMAL YOUNG VOLUNTEERS"

is the bonafide record of research work done by

Mr. R. GOBHY A/L RAMALOO

During the period from September 2003 to March 2004 under our supervision

Signature of Supervisor : 

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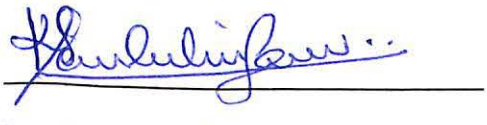
Signature of co-supervisor : 

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CONTENTS

LIST OF TABLES, CHARTS, AND PICTURES.

Abbreviations:

SBP	Systolic Blood Pressure.
DBP	Diastolic Blood Pressure.
HR	Heart Rate.
PP	Pulse Pressure.
MAP	Mean Arterial Pressure.
RPP	Rate Pressure Product.
BMI	Body Mass Index.

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Materials and Apparatus:

EFFECTS OF DEEP BREATHING TRAINING ON EXERCISE-INDUCED CHANGES OF CARDIOVASCULAR PARAMETERS IN NORMAL YOUNG VOLUNTEERS.

ABSTRACT

Deep breathing exercise is found to be useful technique in bringing out changes in physiological and pathological conditions in cardiovascular system. Keeping this in view, the present study was designed to see the effect of deep breathing training on exercise-induced changes of cardiovascular parameters in normal young volunteers.

Effects of Deep breathing training on exercise-induced changes of cardiovascular parameters were studied in normal young healthy student volunteers. Thirty-four college students were divided randomly into two groups of 17 each. Experimental group practiced Deep Breathing Exercise daily 15 minutes in the morning and evening. The control group did not do breathing training. Breathing exercise was done for three weeks. Basal recording was done on the first day and at the end of first week, second week and third week. The recording was repeated after deep breathing training. Recording was done before and after physical exercise. The parameters recorded were SBP, DBP and HR. PP, MAP and RPP were calculated from these values.

It was noticed that after deep breathing exercise there was a gradual decrease in SBP, PP, MAP, and RPP. But there were no noticeable changes in DBP and HR. This is because the deep breathing exercise enhances the parasympathetic activity and slows down the sympathetic activity.

INTRODUCTION

Breathing is an act in which we take air from the atmosphere into our lungs, absorb the oxygen from it into our blood, and expel the air again into the atmosphere together with carbon-dioxide and water vapour. This act of inhalation and exhalation is repeated every four to five seconds. Thus normally we breathe about twelve to fifteen times every minute, each time taking about 500 ml. of air into the lungs. So we inhale and exhale approximately six to seven liters of air per minute. (Rev. James Vinson Wingo, DD, 2003)

Breathing oxygenates every cell of our body, including the brain and the vital organs. Without sufficient oxygen our body becomes more susceptible to medical problems. Recently it had been established that supplemental oxygen administration enhances memory formation significantly in healthy young adults. (Andrew B. Scholey et al., 1999)

On the other hand, the lack of oxygen switches on the sympathetic nervous system. This initiates "fight or flight reaction", which makes us tense, anxious, and irritable. Such breathing also reduces our ability to think clearly, and tends to put us at the mercy of obsessive thoughts and images. Some researchers believe that hyperventilation can actually magnify our psychological problems and conflicts, and that chronic hyperventilation is intimately bound up with our anxieties, apprehensions, and fears. (Dennis Lewis, 1994)

It is believed that breathing exercise can unleash powerful forces and energies within the mind and body. Furthermore breathing exercise accelerates healing on any level, physical, emotional, psychological, spiritual and social. (Koh TC, 1982)

Indeed medical experts agree that breath awareness and breath control can improve the general health and help in the prevention of lot of medical problems and to maintain the general health. (Koh TC, 1982)

Thus, it is the acceptable fact that sufficient supply of oxygen is very essential to keep a person fit physically, mentally and physiologically. But unfortunately, our regular breathing habits does not provide sufficient oxygen in our routine life. If we just start observing our breathing, even at rest, many of us do it faster than the "average" rate of 12 to 15 times per minute (a rate which is already faster than it needs to be).

In fact, many of us, without knowing it, habitually "hyperventilate"--that is, we take quick, shallow breaths from the upper part of our chest. This kind of breathing sharply reduces the level of carbon dioxide in our blood. This reduced level of carbon dioxide causes the arteries, including the carotid artery going to the brain, to constrict, thus reducing the flow of blood throughout the body. When this occurs, no matter how much oxygen we may breathe into our lungs, our brain and body will experience shortage of oxygen. (Dennis Lewis, 1994)

This can be easily rectified simply by practicing, deep breathing exercise or by exercising control over breathing. It is otherwise called pranayama. It is in the process by which the respiration is modified into a more slower and deeper pattern. Just by slowing down the breathing, and making it deeper, a lot of physical, physiological, psychological and social problems can be avoided. The key to slow down our breathing is not to slow it down, but rather to breathe more deeply, using our diaphragm, belly, and lower back in the breathing process rather than breathing through the chest alone. (Dennis Lewis, 1994)

Deep breathing exercise can increase relaxation and treat stress related disorders. It can improve digestion, and prevent indigestion and constipation. It can also improve circulation and correct irregular heartbeats. It can regularize the blood pressure, and improve nervous system function. It has also been shown that it is useful for insomnia, panic disorders, migraines, chronic neck and back pain, peptic ulcer and many other conditions. (Rosemary A. Payne, 2000)

'Belly breathers' breath by using their abdomen to allow maximum amount of air to enter the lung and flow out of the lung. 'Chest breathers' will use only the upper portion of the lung to inhale and exhale. In almost all humans, the childhood type of abdominal breathing changes into the adult type of chest breathing in the process of growing up. But how and when it happens – we are not aware. It may be a natural adaptation brought out by the pressure of stress and tension of lifestyle. Probably the increased stresses of modern life, the increased air pollution, the increased level of radioactivity in the atmosphere and the depletion of the ozone

layer may be the causes for breathing to become much more rapid and shallow. (Mary Concannon, M. A, 2001)

Well! We cannot do anything about these factors. But it is possible, to get the best out of worse simply by modifying the way of breathing. Deep breathing is one of the methods suggested to improve the oxygen supply to the body. And by increasing the oxygen supply alone, it is possible to maintain good health and improve the health in ailing patients. (Mary Concannon, M. A, 2001)

Deep breathing or diaphragmatic or abdominal breathing make the lungs to expand more fully with more expansion at the bottom or base than the top or apex. This helps to increase the exchange of gases. More oxygen to be taken in and more carbon dioxide to be given out. (Mary Concannon, M. A, 2001)

Understanding the importance of deep breathing exercise, many mechanical devices are designed now a day, which are sold over the counter with doctor's prescription only. One of these is called RESPeRATE, which guides the hypertensive patients through a series of breathing exercise to slow down their breathing and lower the blood pressure. (Jennifer Warner, 2002)

REVIEW OF LITERATURE

In conjunction with this study regarding the effect of deep breathing exercise on cardiovascular system, the review was done on previously published research papers and articles related to this field. There are few studies to show the effect of deep breathing exercise on cardiovascular system in normal subjects. Studies on hypertensive patients also have been done to show that deep breathing exercise can reduces cardiovascular problems.

RESPeRATE, a new device also marketed to help the people those who are suffering with hypertension to lower their blood pressure without drugs or complicated treatments. This device is suggested by doctor to the hypertensive patients. (Jennifer Warner, 2002)

The effect of deep breathing exercise on cardiovascular system is obvious. Few studies have been done on effect of deep breathing exercise on normal subjects and cardiovascular patients. A study on six female hypertensive adults had shown that they were able to decrease their mean arterial pressure and heart rate, after practicing breathing exercise for 15 minutes daily. (Jennifer Chodzinski, 2000)

Research in variety of fields has shown that breathing deeply can improve our health in any ways. Now comes evidence that deep breathing helps women to overcome hot flashes, which develop during menopause. Frequency of hot flashes can be reduced by about 50 percent through slow and deep breathing. (Dennis Lewis, 1994)

Grossman E, et al, (2001) hypothesized that routinely applied short session of slow and regular breathing can lower blood pressure. Using a new technology called breath with interactive music, (BIM), 33 hypertensive patients with uncontrolled blood pressure were guided towards slow and regular breathing for 10 minutes daily. At the end of the session it was noticed that there was significant reduction in BP proving that it was effective non-pharmacological modality to reduce the blood pressure. (Grossman et al., 2001)

However, in this study breathing exercise was done along with music. Music itself is supposed to be an effective therapy to lower blood pressure. So it is not clear whether it was the effect of breathing exercise alone or music alone or both together.

Udupa K, et al, found that three months of pranayam training modulated ventricular performance by increasing parasympathetic activity and decreasing sympathetic activity. This study was done on 24 school children. They were divided into two groups. One group practiced pranayam for 20 minutes daily for a duration of three months and the other group were not given any pranayam training. The results showed that, pranayam training produce an increase in RR interval variation (RRIV) and a decrease in QT/QS2, suggesting an enhanced parasympathetic and blunted sympathetic activity respectively. QS2, pre-ejection period / left ventricular ejection time (PEP/LVET) increased significantly, whereas LVET was reduced significantly in pranayam group. (Udupa K, 2003)

Another study on young men shows that 4 weeks of nadi-shodhama pranayam (pranaya breathing exercise) training appear to alter autonomic response to breath holding, probably by increasing vagal tone and decreasing sympathetic discharges. (Bhargava R, 1998). Sudsuang et al., 1991 also found that different breathing pattern will promote different parasympathetic and sympathetic activity. Decreasing the respiratory rate can arouse the parasympathetic activity.

In another study, it was proved that Dan Jeon breathing method was an effective behavioral therapy to reduce blood pressure in essential hypertensive patients. The Dan Jeon breathing method is composed of thirty-minute program including a kind of abdominal-deep breathing, free gymnastics, mental concentration, and physical strength exercise, It was shown that the blood pressure of the Dan Jeon breathing group decreased gradually When the training was finished, the systolic blood pressure was lower by 15.80 mmHg, and the diastolic blood pressure was lower by 10.91 mmHg than the baseline values. (Kim NC, 1994)

Here also abdominal-deep breathing exercise was done along with gymnastics, mental concentration and physical exercise. So it is not possible to say whether the reduction in blood pressure was due to the abdominal deep-breathing exercise or the gymnastic exercise or the physical exercise, because physical exercise and gymnastic exercise themselves cause reduce in blood pressure.

Qi-gong is another type of breathing exercise - ancient Chinese practice along meditation, which is being developed today for therapy of chronic illnesses in China. (Koh TC, 1982), (Zhou MR, Lian MR, 1989) Zhou MR, et al, claimed that Qi-gong relaxation exercise could be used for treatment of pregnancy induced hypertension (PIH). In his study 60 patients with PIH were divided into two groups. One group treated by Qi-gong and the other group was treated by medicine. The microscopical observation of fingernail capillaries showed various degrees of improvement of microcirculation after Qi-gong exercise in Qi-gong group. While for the control group, there was no change.

In another research study, it was established that supplemental oxygen administration significantly enhances memory formation in healthy young adults. (Andrew B. Scholey et al., 1999)

Although many studies show that deep breathing exercise reduces the systolic blood pressure, diastolic blood pressure, and heart rate, there are some negative results also after practicing deep breathing exercise. A study on cardiovascular and respiratory changes during yogic breathing exercise in 17 advanced yoga practitioners shows that heart rate, systolic blood pressure, and diastolic blood pressure increased during yogic breathing exercise. (Stancak A Jr et al., 1991) This study had been done with yogasanas and breathing exercise.

Manipulation of breathing pattern was found to be beneficial for cardiac problem like chronic heart failure. In addition, increase in venous return due to modulation of breathing pattern may help in maintaining blood pressure. This opens an area of future research in the better

management of patients with cardiovascular autonomic dysfunction. (Luciano Bernardi et al., 2001)

Thus many of the studies show that breathing exercise was done for a long period – for about 3 months. In many cases, it was along with either meditation or yogasanas or all together.

LACUNAE

Thus, the review of literature reveals that many researches have been done on the effect of deep breathing exercise along with other physical exercise on cardiovascular parameters. Very few studies were done on the effect of deep breathing exercise alone on cardiovascular parameters on long durations. Effect of deep breathing exercise alone on cardiovascular system in shorter duration is very scanty.

And also most of the studies were done on subject with medical problems like hypertension and angina or on old subjects with cardiovascular problems. Healthy young subjects are less frequently used to study the effect of deep breathing exercise on cardiovascular system especially in Malaysian population. Hence this study is taken up.

OBJECTIVE OF THE STUDY

1. To evaluate the base line values of the parameters.

   (Systolic blood pressure, diastolic blood pressure, pulse rate, pulse pressure, mean arterial pressure, and rate pressure product.)

2. To record the effect of the physical exercise (cycling on cycle ergometer) on these parameters.

3. To evaluate the effect of deep breathing raining on these parameters.

4. To see the effect of deep breathing training on the exercise-induced changes of these parameters.

MATERIALS AND METHODS

Subject selection

Subjects:

35 normal and healthy young male subjects, aged between 18 to 30 years were recruited from the student population of University Science of Malaysia, Health Campus, Kota Bharu, Kelantan. The entire subjects are in the same BMI group. (Appendix VIII)

The subjects were divided into two groups:

- Experimental group – practiced deep breathing exercise.
- Control group – not practiced deep breathing exercise.

Inclusion criteria:

Those subjects who fulfilled the following requirements were selected in this study: -

- The subjects were normal and healthy, without any clinical illness.
- The subjects were within the age group of 18 to 30 years.

Exclusion criteria:

They were not allowed to take part in this study if they were found to be: -

- A smoker or drug addict.
- Treated or undergoing treatment for any cardiac problem, liver disease, respiratory disease, and renal disease.
- An athlete or regular exercising person.
- Not suitable for the study because of any reason given by the medical doctor.

Informed concern:

The entire subjects were given consent form to fill up before they decided to participate in this study. They were asked to read the consent form carefully and sign up the consent form in front of us. [Appendix I - VI]

Doctor in-charge.

Dr. Paramasivam Arumugam, medical officer in surgery department HUSM certified the subjects for their suitability to participate in the study and supervised the procedures. He is also one of the co-supervisor of the study.

Sample size determination

$$m = \frac{2 (f_\alpha + f_\beta)^2 \delta^2 (1 - \rho)}{n s_\chi^2 d^2}$$

δ^2 = Variance of

ρ = Error among Repeated Measures?

d = Detectable Difference

n = Number of repeated Measures per person

s_χ^2 = Subject Variation

FVC1

μ = 4

δ = > 9

d = 0.5

n = 3

s_χ^2 = 0.67

p = ?

$$m = \frac{2 (1.96 + 0.84)^2 0.4^2 (1 - 0.2)}{3 X 7}$$

PEF $\mu = 520$

$\delta = 58$

$d = 10$

$n = 3$

$s_\chi^2 = 5$

$p = 0.2$

$$m = \frac{2\,(1.96 + 0.84)^2\, 18^2\,(1 - 0.2)}{3 \times 4 \times 10^2}$$

S A M P L E S I Z E = 3 4

Ethical committee clearance

The ethical committee of the university approved the test protocol.

Materials

The physical exercise was performed in a well-ventilated room condition. Following are the materials that has been used for the study:

- **Cycle ergometer.** [Appendix XI – picture 5]

  Cycle ergo meter was used for the subjects to perform physical exercise. They were asked to perform cycling exercise for 5 minute with a fixed brake force of 3 Kg weight at the pedaling speed of (40 – 45) rotation per minute (rpm). So the brake power is (120 – 135) Watts. Following are the detail of the cycle ergometer that has been used for the study: -

  Monark Weight Ergometer Model 824E.

- **Automatic digital BP apparatus.** [Appendix X – picture 3]

  An automatic blood pressure apparatus was used to measure the systolic pressure, diastolic pressure, and pulse pressure. Following are the detail of the automatic digital BP apparatus that has been used for the study: -

  OMRON Automatic digital blood pressure monitor with fuzzy logic. (Intelli^{TM} sense)

  Model: T5 (H-EM-762-CI).

- **Stop watch.**

  Stopwatch was used for timing the exercise period.

Statistical analysis.

To determine the differences in blood pressure components between groups and exercise conditions, a 3-way (Group 'Exercise' Time) ANOVA with repeated measures on the second and third factors was used. Groups had 2 levels: experimental and control. Exercise also had 2 levels: before and after exercise. Time had 4 levels: baseline, week 1, week 2, and week 3. Before analyses was carried out, tests were conducted to determine whether the assumptions for (repeated) measures. ANOVA were met. Log transformations were calculated if necessary to normalize the data. Simple effects analyses were conducted for 2-way interactions. The level of significance was set at 0.05.

Explanation of study protocol.

On the first week of this study all the subjects were informed to come to the Physiology laboratory at morning with light breakfast. To avoid any variation caused by heavy breakfast, the subjects were informed to come to the laboratory with light breakfast. The study was planed to be done in the morning because the real basal values could be obtained only after 6 to 7 hours of sleeping rest. Only 3 to 4 subjects were asked to come to the laboratory each week. This was to make sure that the study would be finished before 12 noon. This is important to avoid circadian variation.

When the subject arrived, he was asked to take some rest to avoid any increase in basal reading. The subject signed the consent form in front of the supervisor of the study. The subject's height and weight was measured to calculate BMI. [Appendix IX – picture 2]

The subject's BP and HR were recorded in a sitting position with his arm rested on a table. [Appendix X – picture 4] After recording the basal BP and HR, the subject was asked to do cycling on a cycle ergometer for 5 minutes with a fixed brake force of 3 Kg weight at the pedaling speed of (40 – 45) rotation per minute (rpm). [Appendix XI – picture 5]

After 5 minutes of cycling the subject was asked to stop cycling and sit on the chair. Then the exercise-induced changes in BP and HR were recorded immediately. [Appendix XI – picture 6]

After that, the subjects were taught the DEEP BREATHING EXERCISE by the supervisor. The control group subjects were not taught the DEEP BREATHING EXERCISE. Only the experimental group subjects were taught how to practice the DEEP BREATHING EXERCISE. [Appendix VII]

Then all the subjects were asked to come to the laboratory at the same time after one week, that is on the 8^{th} day, 16^{th} day, and 24^{th} day. All of them were given a flow chart of the study to make it easier for them to follow the schedule. (Flow chart 1 and 2).

I supervised all the experimental group subjects in their hostel rooms to make sure that the DEEP BREATHING EXERCISE was performed regularly.

Method of deep breathing exercise

DEEP BREATHING EXERCISE [Appendix VII]

The subject was instructed to do breathing exercise in standing position.

1. The subject stood with closed eyes and concentration was focused on normal breathing for 2 minutes. After 2 minutes, eyes were opened and the deep breathing exercise was started.
2. Air was must be exhaled slowly through both nostril and simultaneously the stomach was pulled inwards: i.e., the abdominal muscles were contracted to expel air from the lungs. Exhalation was continued for 3 seconds and at the end of 3 seconds, all the air was expelled.
3. Then slowly and deeply inhalation was done through both nostrils. While doing this, the abdominal muscles were stretched, that is, inhalation was abdominal or diaphragmatic. This was done slowly and rhythmically for 3 sec and not fast.
4. At the end of inspiration, there was a pause for 2 seconds: breath was (stopped) with the inhaled air for 2 seconds.
5. Then exhalation was done through the nostrils for 3 seconds as in steps 1.

So one respiratory cycle was completed in 8 seconds. Exhalation 3 seconds, inhalation 3 seconds and pause 2 seconds- (3+3+2=8 sec) with the respiratory rate of 7-8 per minute. This is in first week.

In the second week, the timing was 4+4+2=10 seconds, at the rate of 6 breaths per minute. In third week, it was 5+5+5=15 seconds, at the rate of 4 breaths per minute.