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Original Article

Effect of breathing exercises on respiratory indices and anxiety level in individuals with generalized anxiety disorder: a randomized double-blind clinical trial

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Abstract. [Purpose] The purpose of this study was to assess the efficacy of breathing exercises alongside traditional therapy on respiratory indexes and the level of anxiety of generalized anxiety disorder patients. [Participants and Methods] Forty-one patients were assigned a study group undergoing medication and routine counselling plus breathing exercises (EXS), and a control group received medication and routine counselling only (Non-EXS). Every two weeks, patients are called (weeks 2, 4, 6, and 8) to monitor their schedule adherence. [Results] This study's results showed FEV1/FVC ratio significantly increased in the EXS group in the second study follow-up period after two months. Anxiety, FVC, FEV1, Etco2, respiration, and pulse rate over time have tended towards desirable results in the exercise group than control groups, especially after two months, but significant differences not seen. [Conclusion] This study's findings indicated that breathing exercises could improve generalized anxiety disorder's pharmacotherapy and psychotherapy. Our data bring up this hypothesis that longer follow up, increasing breathing period, and more exercising is associated with higher outcome.

Key words: Generalized anxiety disorder, Breathing exercises, Respiratory

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INTRODUCTION

Generalized Anxiety Disorder (GAD) is a chronic and disabling disorder characterized by anxiety and uncontrolled worrying in most of a person's daily activities and family relationships[1)]. it is usually associated with somatic complaints (tremor, palpitations, dizziness, nausea, muscle tension, etc.) and psychic symptoms (difficulty concentrating, nervousness, sleep disturbances, etc.) for at least a six-month period[2)]. In some countries, the prevalence of this disorder was reported up to 6.2% and 3.7% in medical care centers that reach about 89% with comorbidities. Females affected 1.5 to two times more than males[3)].

Respiratory abnormalities in anxiety disorders were reported in patients with GAD. Hyperventilation symptoms or disruption in pressure CO_2 (PCO_2) level in large percentage of anxiety patients have been shown[4, 5)]. In this regard, breathing training was shown regardless of the type of method, decreasing hyperventilation and subsequently reducing anxiety[6, 7)]. Buteyko breathing technique (BBT) is one of the breathing exercises to achieve this. In this method, patients trained with

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reduced-volume breathing how consciously control their breath to inhibit the starting breath-relating symptoms. In BBT, focusing on mouth breathing and upper chest breathing improves the dysfunctional breathing in chronic hyperventilation which is seen in GAD[8]. It was indicated that BBT has a positive effect on controlling breath rating and improves control and quality of life in asthma patients[9, 10]. But there is a lack of the evidences to evaluate this mechanism in the treatment of GAD patients.

Alongside the medications, psychotherapy like cognitive behavioral therapy is recommended to increase the outcome of GAD treatment. In the meantime, it was demonstrated that hypocapnia, one of the major hyperventilation symptoms, can reduce the result of cognitive-behavioral therapy[11]. By breathing retraining, the treatment outcome will improve[12]. There is a wide spectrum of drugs are used to treat GAD, but there are several side effects that influence the quality of treatment. Hence, there is a need for alternative or supplemental therapeutic approaches alongside the traditional treatment to reduce the side effects. In recent years, there was an increasing interest in evaluating the impact of breathing exercises on mental disorders. In the current clinical trial, we investigate the impact of breathing exercises alongside traditional therapy on respiratory indices, and the level of anxiety of patients to improve quality of life and reduction period of treatment.

PARTICIPANTS AND METHODS

The current survey is a double-blind randomized trial comparing the effect of breathing exercises besides the medication and routine counseling versus the control group received medication and routine counseling only. Patients were recruited to the department of Musculoskeletal Rehabilitation Research Center in Ahvaz Golestan Hospital, Ahvaz, Iran, from November 2019 to December 2020. The study was based on the approval of the Medical Ethics Committee of Jundishapur Ahvaz University (Reference Number: IR.AJUMS.REC.1398.221) and registered at the Iranian Registry of Clinical Trials (code IRCT20181017041374N1). Eligibility criteria required individuals to have received: patients with age between 18–45 years, have a higher degree than a diploma, no abuse to drug and alcohol, not participating in professional physical activity or sports professionally and earning the necessary points from the Beck Activity Level questionnaire and Individuals with respiratory hyperventilation pattern who scored 23 out of 64 in the evaluation by Nijmegen questionnaire. Exclusion criteria were considered as the history of nervous-musculoskeletal disease or injury which interrupt with the breathing, heart rate exceeds normal based on age, having a cardiovascular disease based on self-reported individuals, the existence of any disruptions in the higher respiratory tract, patients with a mental disorder such as major depression, panic and other psychiatry disorder, and pregnant women. Furthermore, patients with excessive worry during the project, which can disrupt the research process, were excluded too. There were no restrictions for gender and race. All patients' informed written consent was provided before study entry.

Patients were randomly assigned to the EXS group or Non-EXS group by using non-stratified different block randomization. An independent statistician carried it out. For allocation concealment, index cards were placed in opaque, sealed envelopes. A research assistant not involved in recruitment or assessment opened them in ascending order after baseline assessment. The physiotherapist that assessed patients have no information about the group assignment.

Medications were prescribed for all patients, and also all patients received psychiatric counseling via all periods of treatment. Drug dosage was constant via the study, and the patients had to agree with it. The EXS group was instructed by a trainer (certified in Buteyko procedure) with the following plane: 1. beginning control pause, 2. Slow breathing, 3. Putting together CP and slow breathing. Each session started and ended with the control pause. Patients instructed sit quietly, relax the body, slow breath then gently close their nose, until they feel the first need to breathe, then release the nose and take a breath. They advise to reduce breathing rate and extended pauses in daily activities. Nasal over oral breathing was encouraged. In the slow breathing stage, patients were asked to place the finger under the nose, after inhalation, breath out slowly on the finger that feel warm air, so they concentrate on calming their breath to decrease the volume of warm air they feel[13]. Moreover, diaphragmatic breathing, which includes coordinating abdominal movements and breathing with each other were trained too. Finally asked of patients carried out a combination of techniques and conducted during daily activities. Respiratory exercises were done once a day for 15 to 20 min for at least four days a week, for one month of home practice and followed by two months. Every two weeks, patients are called (weeks 2, 4, 6, and 8) to monitor adherence to their schedule and be given guidance and assistance if they encounter any problems. After one month, patients recurred to evaluating their situation. All measures were collected at Baseline, after one month and a two-month follow-up.

General Anxiety Disorder-7(GAD-7), and Beck anxiety inventory (BAI) were used to assess the self-report measures of anxiety, and diagnosis of GAD, respectively. Nijmegen questionnaire (NQ) is used to diagnose hyperventilation syndrome and the severity of dysfunctional breathing patterns. Spiroanalyzer ST-95 (Fukuda Sangyo, Tokyo, Japan) was used to evaluating respiratory spirometry indexes, including Forced Expiratory Volume in the First second (FEV1), Forced Vital Capacity (FVC), and the ratio of FEV1/FVC (%). The concentration of respiratory indexes capnometry, including end Tidal CO_2, $PaCO_2$, PaO_2, heart rate, and breath rate, were assessed by a capnograph instrument (Viamed Company-2500-s, UK). Outcome measurements were assessed in random order at baseline, after one month and a two-month follow-up.

Descriptive statistics of qualitative and quantitative variables were shown as frequency (percentage) and mean ± standard deviation (SD). Independent-samples t-test and Mann–Whitney U test were used to test the difference among quantitative variables in the study groups (EXS group and Non-EXS group). The χ^2 test was used to test the difference of frequency

distribution of qualitative variables like sex in the study groups. Besides, the normality of data was assessed using Shapiro-Wilk test. Generalized estimating equations (GEE) were utilized to assess the changes in quantitative outcome variables over the study time (Baseline, Month1, and Month2). P<0.05 was regarded as a significant statistical difference. Data analysis was done using statistical software SPSS version 22.0 for Windows. The sample size of this study was determined using G*Power, Version 3.0.10, (Franz Faul et al., Universitat Kiel, Germany). 42 patients (21 per group) were calculated with 80% power, effect size of 0.5 and type I error a=0.05

RESULTS

Seventy-three patients were recruited for this study. Forty-eight eligible patients who matched the inclusion criteria were identified with GAD. 4 patients dropped out in the first period due to interference with their job times, and three of them in boost sessions due to the incompletion of treatment. Finally, 41 patients were included and analyzed (EXS=21, non-EXS=20). 68.2% (28) of all patients were female, and 31.8% were male (Table 1). There were no differences between the two groups for age, body mass index (BMI), height, weight, and duration of disease, which indicated the studied groups were identical in terms of the characteristics of participants in the study (Table 1).

GEE analysis indicated that the clinical outcomes, including Nijmegen, BAI, and GAD7, after one and two treatments further reduction in EXS group compared to Non-EXS group, significant differences between two group were not observed (Table 2). Spirometry respiratory parameters, including FVC, FEV1, and FEV1/FVC ratio after one and two treatments significantly increased in both groups. FVC and FEV1 trend to increase especially after two months in EXS than Non-EXS group, but significant differences not seen. Further analysis revealed that FEV1/FVC ratio increased significantly in the EXS group in the second study follow-up period after two months (Table 2). Capnometry respiratory parameters trend to increase especially after two months in EXS than Non-EXS group, but significant differences not seen (Table 2).

DISCUSSION

GAD is a common anxiety disorder characterized by persistent worry, restlessness, increased heart rate, hyperventilation, and trouble with concentration. It can occur at any age. The treatment of GAD is one of the most important challenges worldwide, especially when it has some overlaps with panic disorder. There are several well-known treatments for GAD, but sometimes prolonging the treatment period affects the quality of treatment and has adversely impacted the psychotropic aspect of patients, especially in young adults. Current approaches to the management of GAD are based on pharmacotherapy and psychotherapy; hence, complementary therapies can improve the progression of therapy. Breathing training is one of the complementary therapies shown to reduce hyperventilation and its beneficial effects on respiratory tract diseases (i.e., asthma) and panic disorder[8]. Breathing pattern with impact on the brain alters the signals between brain and body[14]. BBT is one of the essential methods shown to help control anxiety disorders and stress[15]. Hyperventilation is one of the main annoying events that frequently occur in GAD. To overcoming this phenomenon, it was indicated that diaphragmatic breath is helpful. BBT involving different aspects of breathing, directly affects decreasing CO_2 and increasing O_2 delivery to the tissue. A considerable amount of literature was published on the influence of breathing methods on the panic disorder or the impact of BBT on respiratory disorder (i.e., asthma)[16], but there has been no detailed investigation about the effect of breathing exercises on GAD. This paper shows the consequence of breathing exercises on treatment outcomes compared to traditional therapy (medication and routine counseling).

We analyzed whether a breathing exercises intervention in GAD might improve the clinical outcome of treatment. Over the course of 2 months, patients completed once a day for 15 to 20 min. Our analysis showed FEV1/FVC ratio significantly increased in EXS group in the follow-up period after two months. In line with this result, Jerath et al. suggest breathing

Table 1. Baseline characteristics of the study participants

Variable		Group	
		Non EXS (n=20)	EXS (n=21)
Gender	Female	11 (55%)	17 (80.95%)*
	Male	9 (45%)	4 (19.05%)
Age (years)		32.60 ± 8.10	34.81 ± 5.85**
Height (cm)		171.85 ± 9.62	167.57 ± 7.85***
Weight (kg)		81.05 ± 15.43	77.76 ± 13.99***
BMI (kg/m^2)		27.49 ± 4.97	27.82 ± 5.43***
Duration of illness (days)		761.75 ± 33.21	748.38 ± 37.57**

*χ^2 test, **Independent-samples t-test, ***Mann-Whitney U test. p>0.05 in all of variables between two groups.
EXS: exposure; Non-EXS: non-exposure; BMI: body mass index.

Table 2. Descriptive statistics of clinical outcomes over time in the exposure (EXS) and non- exposure (Non-EXS) groups

Variables	Groups	Time points		
		Baseline	Month1 (Post intervention)	Month2 (Follow up)
Nijmegen†	EXS	37.76 ± 10.24	15.62 ± 3.99	11.14 ± 3.21
	Non EXS	37.85 ± 9.22	16.80 ± 3.27	13.45 ± 3.19
BAI‡	EXS	40.90 ± 10.53	18.62 ± 3.37	13.24 ± 3.62
	Non EXS	41.15 ± 10.42	18.25 ± 3.06	15.25 ± 3.13
GAD-7§	EXS	19.33 ± 1.91	7.38 ± 1.83	5.86 ± 1.91
	Non EXS	19.15 ± 1.93	7.70 ± 1.69	5.90 ± 1.25
FVC (L)	EXS	3.88 ± 1.09	4.14 ± 0.96	4.29 ± 0.91
	Non EXS	4.49 ± 1.41	4.64 ± 1.32	4.69 ± 1.30
FEV1 (L)	EXS	2.82 ± 0.87	3.28 ± 0.72	3.89 ± 0.85
	Non EXS	3.26 ± 0.92	3.84 ± 1.04	4.01 ± 1.11
FEV1/FVC (%)	EXS	73.14 ± 12.52	79.72 ± 9.52	90.89 ± 6.59*
	Non EXS	74.41 ± 13.45	83.60 ± 9.51	85.99 ± 8.30
$ETCO_2$ (%)	EXS	3.85 ± 0.80	4.90 ± 0.46	5.32 ± 0.49
	Non EXS	3.87 ± 0.58	4.83 ± 0.37	5.16 ± 0.30
RR (breath/min)	EXS	20.57 ± 2.86	16.71 ± 2.53	15.33 ± 1.83
	Non EXS	21.20 ± 3.11	18.30 ± 3.77	16.80 ± 2.98
PR (beat/min)	EXS	88.71 ± 11.18	76.24 ± 7.86	69.95 ± 7.61
	Non EXS	91.60 ± 10.84	83.95 ± 11.72	78.10 ± 12.44

BAI: Beck anxiety inventory; GAD-7: Gad anxiety disorder; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in First second; SPO_2: saturation of O_2; RR: respiratory rate; PR: pulse rate; $ETCO_2$: end-tidal CO_2; EXS: exposure; Non-EXS: non-exposure.
†0–64 points; 23 out of 64 hyperventilation; ‡0–63 points; 26–63 severe anxiety; §0–21 points; 15–21: severe anxiety.

techniques could be used as complementary intervention for anxiety disorder due to relationship between respiration and emotions and the effect of respiration on autonomic system[17]. FVC, and FEV1 parameters, $ETCO_2$, respiratory and pulse rate over time have tended towards desirable results in the EXS group than Non-EXS groups. These results indicated that breathing exercises successfully decreased symptoms associated with dysfunctional breathing patterns in GAD patients; however, the associations were not significant differences. Short follow-up or insufficient exercise can explain the lack of significance. Our data bring up this hypothesis that longer follow-up and more exercising is associated with higher outcomes. Additional to the longer follow-up, another explanation for lack of significance in respiratory parameters can be the point to low control pause or control pause lower than 25 seconds; it was indicated that the more extended control pause session is accompanied with greater impact[11]. This is in line with recent evidence that revealed that breathing techniques alongside medications in the long period helps address anxiety disorder[18].

This study's finding showed anxiety after one and two treatments decreased in both group; however, there were tended towards desirable results in the exercise group. McPherson et al. in a pilot study showed multimodal interventions focusing on self-care behaviors is superior on conventional treatment in GAD patients. In this study, GAD patients receive acupuncture, massage, yogic breathing exercises, nutrition counseling, and exercise. They reported reduction in anxiety in these patients but this study had not control group[19]. In another investigation that conducted to evaluate the influence of BBT on physical activity and management of stress in athletes, it was revealed, BBT is associated with decreased heart rate and anxiety; this is in accordance with our results that heart rate decreases and patients had a better sense and more relaxation[11]. These findings are consistent with Sajadi et al.'s recent data, who reported that diaphragmatic breathing helps reduce anxiety in women[20]. BAI is routinely used for GAD screening and evaluating treatment efficacy among respiratory parameters. However, recently, BAI is accompanied by a high number of false positives it can explain the lack of significance in ours[21].

Dysfunction in the respiratory tract or pulmonary disease is accompanied by anxiety disorder[22, 23]. In this regard, GAD patients indicated a delayed or reduction in attention peak (P3) compared to normal participants[24], which influences medication treatment outcome and accounts for one of the main respiratory complications in GAD. Additional to P3, the lung dysfunction in GAD patients manifests itself as a reduction in FEV1/FVC ratio[25], so the correction of breath pattern accelerates the therapy progression. It is in agreement with our findings that BBT with increasing FEV1/FVC ratio in the EXS group was successful in better managing disease. These results differ from Boaviagem et al., who reported breathing exercising does not influence pregnant women's anxiety[26]. It might be to, the secretion of more and additional hormones in pregnancy that may influence the outcomes. This study had some limitations. There was control group with no intervention. Therefore, the effect of time on the recovery could not be obtained. In addition, exercise period in this study was low, more exercising with longer period suggest in future studies. It *is not* possible to *blind patients* or therapists in this study due to the nature of

the intervention. Finally, as most participants in the study were females and gender distribution was not equal between groups that could limit the generalizability of the findings.

This study's findings indicated that breathing exercises could improve the pharmacotherapy and psychotherapy of GAD. In this issue, the breathing period and intensities one of the most important factors considered in a later investigation. Moreover, evaluating the impact of breathing exercises in a certain age of patients to reveal the interference of age is also recommended.

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Conflicts of interest

None.

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