Original Article

Effect of Local Hyperthermia on Respiratory Indices of Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Background: Change in respiratory indices is the most common problem in Chronic Obstructive Pulmonary Disease (COPD) patients. This problem is managed through pharmaceutical and non-pharmaceutical methods. This study aimed to determine local hyperthermia effect on respiratory parameters of COPD patients. **Materials and Methods:** This randomized controlled trial study was conducted on 46 patients with COPD referred to Allameh Bohlool Hospital in Gonabad, Iran in 2019. The participants were randomly assigned into two groups using quadrupled blocks. In both groups, a local pack was placed on the anterior chest for 23 min twice daily for 5 days. In the intervention group, the temperature of the hot pack was 50° and in the placebo group was the same as the body temperature. Respiratory indices including force vital capacity (FVC), forced expiratory volume in first second (FEV1), etc., were measured and compared before and after the last intervention in both groups. To gather data, demographic information form and respiratory indices record form were used. **Results:** Compared to before the intervention, all respiratory indices such as vital capacity (VC) ($z = -4.25$, $p < 0.001$), FEV1 ($t_{22} = -114.18$, $p < 0.001$), PEF ($t_{22} = 5.91$, $p < 0.001$) in the experimental group were increased significantly. Moreover, the difference in the mean respiratory indicators such as Pick Expiratory Flow rate (PEF) ($t_{44} = 94.63$, $p < 0.001$) and SPO_2 ($z = -3.27$, $P < 0.05$) was also statistically significant in the two groups before and after the intervention. **Conclusions:** Local hyperthermia is effective in the improvement of respiratory indices among COPD patients, but it is recommended to conduct further studies before the implementation of this approach.

Keywords: *Chronic obstructive, hyperthermia, pulmonary disease, respiration*

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a disease accompanied by a continuum of respiratory symptoms and restriction of airflow.[1] According to the prediction of the World Health Organization, more than 200 million individuals around the world live with COPD.[2] A survey study conducted in Iran reported the prevalence of COPD as 5.7%.[3] This disease is a condition that causes high morbidity and mortality globally and is currently considered one of the main public health issues.[4] Patients with COPD experience symptoms including short breathing, coughing, and fatigue.[3]

To assess the status of the disease and the efficacy of specific pharmaceutical methods for COPD, respiratory symptoms are assessed regularly.[5] According to Peter, measuring lung function by spirometry is the most sensitive way to diagnose COPD and determine lung function.[6] Symptoms aggregation in patients with COPD leads to serious outcomes and is related to an increase in using health care, a decrease in lung function, an increase in referral to hospital, and even death.[2] Therefore, the treatment and control of patients with COPD symptoms are most important. COPD is controlled pharmaceutically and nonpharmaceutically. Airway dilators, corticosteroids, antibiotics, and expectorants are the medications used to treat this disease.[7] These medications cause unexpected side effects in addition to useful effects and despite the high costs of treatment for patients with COPD, a thorough recovery could not be achieved.[8] Therefore, nonpharmaceutical strategies are developed to manage this disease. Training patients and their families and providing special services for these

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patients such as breathing exercises, physical therapy, and occupational therapy to save energy during daily activities are among the appropriate nursing interventions.[9] One of the recommended nonpharmaceutical methods to relieve symptoms of the patients is hyperthermia, which is expected to improve these patients through various mechanisms.[10] During the increase in the temperature of body tissues, numerous changes occur. One of these changes is the dilation of blood vessels which via the increase in blood flow in inflamed and damaged regions removes toxic metabolites such as histamine and bradykinin and improves oxygen flow.[11] Besides, according to other studies, hyperthermia increases the synthesis of Nitric Oxide (NO).[12] NO is used as a bronchodilator and plays a role in the regulation of the diameter of respiratory tracts, preserving mucosa, and repairing it.[13]

For hyperthermia, various methods, including local hyperthermia, sauna, and warm water bathing are used.[11] Studies results indicate that sauna therapy is accompanied by a decline in the risk of acute and chronic respiratory disorders, improvement of the obstruction of airways, and improvement of life quality in patients with COPD. In addition, no side effect caused by sauna therapy was observed.

Although the benefits of systemic heat therapy are proven in previous studies,[14,15] the access to saunas and systemic heat therapy in medical centers is difficult and expensive. Therefore, we do not see its usage in medical centers. Local hyperthermia using a hot pack is one of the techniques used to apply heat to the body surface.[16] Topical hyperthermia is a cheap, accessible, and easy intervention and is more accepted publicly. Mohammadpour *et al*.[17] in their study found that localized hyperthermia of the chest is effective in improving the respiration of patients with Acute Coronary Syndrome (ACS). However, Bito *et al*.[18] in their study, expressed that hyperthermia with a hot pack could not change respiratory functions. In terms of the contradictory results of studies and as the effect of topical hyperthermia with a hot pack on respiratory indices in the patients with COPD is not yet investigated (we could not find the effects), this study aimed to determine the effect of local hyperthermia on respiratory indices in patients with COPD.

Materials and Methods

This randomized controlled clinical trial was conducted from December 2018 to March 2019. The research was done in internal wards of the training hospital covered by Gonabad University of Medical Sciences, Gonabad, Iran. The study sample included all patients with COPD who were referred to the study place.The study was registered in the Iranian clinical trial registry center IRCT20161004030141N1.

Inclusion criteria for this study included the age of 40–70 years,[19] stage 2–4 of the disease according to the Global Initiative for Obstructive Lung Disease (GOLD) criterion,[9,14] Body Mass Index (BMI) of 18.5–25, no history of mental and hyperthyroidism based on the patient's self-report and physician approval, consciousness, speaking and communication ability, stable physiological state to answer the questions, no structural disorder or known deformity and lesions (swelling, sores, scratches, and rash) in the chest area, not having conditions of contraindication of spirometry not controlled Hypertension (HTN), communicable respiratory infection, active hemoptysis, recent surgery of the eye or ear, myringorupture, recent history of Cerebrovascular Accident (CVA) or embolism, history of Myocardial Infarction (MI) or unstable angina in recent 6 weeks. Exclusion criteria included lack of tendency and cooperation to continue participating in each step of the study, the incidence of any clinical conditions, which need specific diagnostic and therapeutic attempts, and if local hyperthermia is contraindicated according to the opinion of the specialist, and in case of loss of consciousness during the treatment. The researcher identified the criteria based on interviews, physical examinations, and spirometry indicators. The sample size was computed at 23 individuals using G-power software version 3, T family tests, and statistical test comparing two independent groups and considering confidence coefficient of 95%, test power of 90%, and effect size of 1.09, which finally by 5% attrition rate for each group, 24 individuals were considered [Figure 1].

The research units were selected based on their availability according to the study's inclusion criteria and were then randomly assigned to the two groups using quadrupled blocks. In this method, the six possible conditions were listed, one number was assigned to each block, and a number was selected by a person other than the researcher by random. The main researcher registered patients and assigned them to the intervention and control groups. Besides, blinding was not performed. The data were collected using the patient's demographic profile and the form of recording respiratory indices. The demographic information form included questions such as age, gender, weight, height, educational level, marital status, hospitalization, smoking history, history of underlying disease, which were completed before the intervention based on the patient's medical record or through interviewing the patient or self-report. Form of recording respiratory indices included Vital Capacity (VC), Force Vital Capacity (FVC), forced expiratory volume in first second (FEV1), FEV/FVC, Pick Expiratory Flow rate (PEF), forced expiratory flow at 25%–75% (FEF25-75), blood oxygen saturation (SPO_2), and Respiration Rate (RR). Spirometer system Miri Spir model manufactured by Italy and pulse oximeter system model Nellcor manufactured by America were used to measure respiratory indicators.

The patients in both groups received routine COPD treatments. At baseline, respiratory indices in both groups

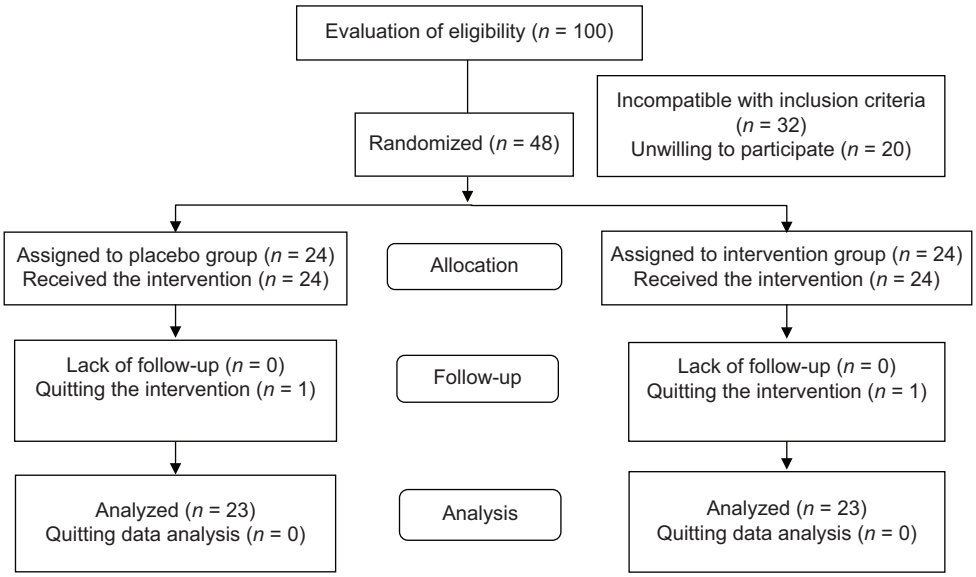

Figure 1: Consort diagram for the patient selection mechanism

were measured and recorded. In the intervention group, hot packs were used for local hyperthermia, which was a special cotton bag with a standard size of 25 × 35 containing hydrophile silicate and was heated to 50°C by a hydrocollator. It was then placed in a special towel and was used for 23 min on the front of the chest in a semi-fowler position.[11,17] The hot pack was used twice a day every 12 h. The hyperthermia continued for 5 days. In the placebo group, a similar hot pack was used at the same time yet with a temperature of 37°C (equal to body temperature) twice a day for 5 days, the respiratory indices were measured and recorded again 24 h after the last intervention in both groups.

The descriptive statistics were reported as frequency, percentage, and mean (SD). Mann–Whitney U test, Chi-square test, Wilcoxon signed-rank test, paired t-test, and independent t-test were used to analyze the data. The significance level was considered as 0.05. The statistical software used for data analysis was SPSS software (version 23, IBM Corp. Armonk, NY, USA).

Ethical considerations

After obtaining the approval of the ethics committee (IR.GMU.REC.1398.079), the study was started. The participants were informed of the objectives of the study, and a written informed consent was signed by them.

Results

The data relating to 46 patients with COPD were analyzed. The mean (SD) age of the participants was 63.05 (8.45) years. Most of the participants in this study were male patients (52.17%). Results of tests of Man–Whitney U and Chi-square tests showed no significant difference regarding demographic information among study groups, and the groups were homogeny in this regard [Table 1].

Results did not show any significant statistical difference in FEV1/FVC ($z = -1.49$, $p = 0.13$, Wilcoxon test), FEF25-75 ($z = -4.19$, $p = 0.82$, Wilcoxon test), SPO_2 ($z = -1.19$, $P = 0.23$, Wilcoxon test), and RR ($z = -0.63$, $p = 0.49$, Wilcoxon test) before and after intervention in the placebo group, but according to the results of this test and VC ($t_{22} = -15.90$, $p < 0.001$, Paired t-test), FVC ($z = -7.70$, $p = 0.007$, Wilcoxon test), FEV1 ($t_{22} = -114.18$, $p < 0.001$, Paired t-test), and PEF ($t_{22} = -52.36$, $P < 0.001$, Paired t-test) were different in the placebo group, so after the intervention they were decreased. Moreover, there were significant statistical differences in all respiratory indicators such as VC ($z = -4.25$, $p < 0.001$, Wilcoxon test), FEV1 ($t_{22} = -114.18$, $p < 0.001$, Paired t-test), PEF ($t_{22} = 5.91$, $p < 0.001$, Paired t-test), SPO_2 ($z = -4.22$, $p < 0.001$, Wilcoxon test) and etc., before and after intervention in the experimental group so that these indicators after the intervention in this group were increased.

After the intervention, there was no significant statistical difference in terms of VC ($t_{44} = 1.20$, $p = 0.23$, Independent t-test), FVC ($t_{44} = 1.20$, $p = 0.30$, Independent t-test), FEV1 ($t_{44} = 0.86$, $p = 0.39$, Independent t-test) between the two placebo and experimental groups. But there were significant statistical difference in respiratory indicators including FEV1/FVC ($z = -4.63$, $p < 0.001$, Mann–Whitney U test), PEF ($t_{44} = 2.59$, $p = 0.01$, Independent t-test), FEF25-75 ($z = -2.07$, $p = 0.03$, Mann–Whitney U test), SPO_2 ($z = -2.81$, $p < 0.001$, Mann–Whitney U test) and RR ($t_{44} = -6.24$, $p < 0.001$, Independent t-test) after intervention between the two placebo and experimental groups [Table 2].

The results showed the difference in the mean of all respiratory indicators such as VC ($t_{44} = 94.63$, $p < 0.001$, Independent t-test), FEV1 ($t_{44} = 61.16$, $p < 0.001$, Independent t-test), FVC ($z = -5.87$, $p < 0.001$, Mann–

Table 1: Comparison of demographic information of the patients with COPD* between the two groups

Variable	Experimental group (*n*=23) Mean (SD)**	Placebo group (*n*=23) Mean (SD)	Test statistic		*p*
Age	63.69 (9.17)	63.30 (7.87)	-0.35[$]		0.72
Weight	55.39 (8.01)	57.10 (9.13)	-0.58[$]		0.55
Height	158.52 (7.21)	162.17 (9.20)	-1.43[$]		0.15
BMI***	21.99 (2.46)	21.67 (2.68)	-0.61[$]		0.53
Hospitalization	6.34 (3.60)	4.21 (2.10)	-1.86[$]		0.06
	n* (%)*	***n* (%)**	**Test statistic**	**df**	*p*
Gender					
Male	10 (43.47)	14 (60.86)	1.39[$$]	1	0.23
Female	13 (56.52)	9 (39.13)			
Stage of disease					
2nd	9 (39.13)	4 (17.39)	3.01[$$]	2	0.22
3rd	9 (39.13)	14 (60.86)			
4th	5 (21.73)	5 (21.73)			
Smoking history					
Yes	5 (21.73)	5 (21.73)	0.00[$$]	1	1.00
No	18 (78.26)	18 (78.26)			
Occupation					
Governmental/self-employed	5 (21.73)	8 (34.78)	3.85[$$]	3	0.42
Household	12 (52.17)	9 (39.13)			
Retired	6 (26.08)	6 (26.08)			
Income					
Insufficient	10 (43.47)	16 (69.50)	3.18[$$]	1	0.07
Sufficient	13 (56.52)	7 (30.43)			
Place of residence					
Urban	11 (47.82)	6 (26.08)	2.33[$$]	1	0.12
Rural	12 (52.17)	17 (73.91)			
History of underlying disease					
Yes	12 (52.18)	11 (47.82)	0.08[$$]	1	0.76
No	11 (47.82)	12 (52.18)			
Type of underlying disease					
Diabetes and heart disease	1 (11.11)	3 (27.27)	1.48[$$$]	1	0.68
Hypertension	8 (88.89)	8 (72.73)			
History of respiratory disease					
Fewer than 1 year	1 (4.34)	6 (26.08)	4.21[$$]	2	0.12
1-5 years	14 (60.86)	11 (47.82)			
More than 5 years	8 (34.78)	6 (26.08)			

*Chronic Obstructive Pulmonary Disease. **Standard deviation. ***Body Mass Index. ****Number (Percent). [$]Mann–Whitney. [$$]Chi square. [$$$]Fisher's exact test

Whitney U test), PEF (t_{44} = 94.63, $p < 0.001$, Independent t-test), SPO_2 (z = -3.27, $p < 0.05$, Mann–Whitney U test) was statistically significant in the two groups before and after the intervention [Table 3].

Discussion

This study aimed to investigate the effect of local hyperthermia on respiratory indices of patients with COPD. The results showed that local thermotherapy of the chest effectively improves respiratory indices. To justify the improvement of respiratory indices, it seems that physiologic changes caused by hyperthermia could be effective. The increase of blood flow of the area, acceleration of excretion of waste and harmful substances produced by metabolism, and facilitating of chemical reactions are examples of these changes Moreover, hyperthermia is effective in increasing oxide nitric synthesis, which plays a role to regulate the diameter of airways, preserving mucosa, and its repair.[13] It can be said that the local hyperthermia causes the decrease in the resistance of pulmonary vessels and their dilation. Following that exchange of oxygen through alveoli on the lung surface and blood improves.[20] Many diseases related to abnormal function of the respiratory system are caused in terms of insufficient performance of respiratory muscles.[21] Weakness of respiratory muscles in COPD is effective in changes of respiratory indices.[18] The results of the study by Kim *et al*.[22] represent that 8 weeks of local hyperthermia improves the strengths of muscles and

Table 2: The comparison of mean respiratory indices before and the intervention between two groups

Respiratory indices	Experimental group Mean (SD)	Placebo group Mean (SD)	Test statistic	df	*p*
VC* [L]					
Before	2.56 (0.58)	2.56 (0.89)	-0.03$	44	0.97
After	2.84 (0.57)	2.58 (0.84)	1.20$	44	0.23
Test statistic	-113.88	-15.90			
df	22	22			
p	<0.001$$	<0.001$$			
FVC** [L]					
Before	1.24 (0.67)	1.30 (0.65)	-0.13$$$	-	0.89
After	1.47 (0.67)	1.27 (0.64)	1.20$	44	0.30
Test statistic	-4.25$$$$	-7.70$$$$			
df	-	-			
p	<0.001	0.007			
FEV1*** [L]					
Before	0.86 (0.38)	0.91 (0.41)	-0.41$	44	0.67
After	1.00 (0.38)	0.89 (0.41)	0.86$	44	0.39
Test statistic	-114.18$$	8.20$$			
df	22	22			
p	<0.001	<0.001			
FEV1/FVC [L]					
Before	43.26 (18.81)	36.78 (11.54)	1.40$	44	0.16
After	62.32 (8.03)	41.03 (11.64)	-4.63$$$	-	<0.001
Test statistic	-3.83$$	-1.49$$$$			
df	-	-			
p	<0.001	0.13			
PEF**** [L/S]					
Before	1.27 (0.62)	1.33 (0.68)	-0.32$	44	0.74
After	1.74 (0.63)	1.24 (0.67)	2.59$	44	0.01
Test statistic	5.91$$	-52.36$$			
df	22	22			
p	<0.001	<0.001			
FEF25-75***** [L/S]					
Before	81 (0.38)	0.86 (0.41)	-0.42$	44	0.67
After	3.06 (10.01)	0.74 (0.27)	-2.07$$$	-	0.03
Test statistic	-0.22$$$$	-4.19$$$$			
df	-	-			
p	<0.001	0.82			
SPO_2****** [%]					
Before	91.82 (2.70)	92.04 (2.43)	-0.10$$$	-	0.92
After	94.26 (2.28)	92.52 (1.78)	-2.81$$$		<0.001
Test statistic	-4.22$$$$	-1.19$$$$			
df	-	-			
p	<0.001	0.23			
[beat per minute] RR*******					
Before	21.26 (1.71)	21.82 (1.64)	-1.24$$$	-	0.21
After	18.47 (1.64)	21.78 (1.92)	-6.24$	44	<0.001
Test statistic	-4.22$$$$	-0.68$$$$			
df	-	-			
p	<0.001	0.49			

*Vital Capacity. **Forced Vital Capacity. ***Forced Expiratory Volume in First Second. ****Pick Expiratory Flow Rate. *****Forced Expiratory Flow at 25%-75%. ******Blood Oxygen Saturation. *******Respiration Rate. $Independent *t*- test. $$Paired *t*-test. $$$Mann–Whitney. $$$$Wilcoxon

increases skeletal muscles capillary in muscular fibers. Their study showed that inactive heat could be a tool for the treatment of conditions related to capillary weakness and muscle weakness. Yıldırım *et al*.[23] showed in one

Table 3: The comparison of the changes in the mean respiratory indices before the intervention between the two groups

Respiratory indices	Experimental group Mean deviation (SD)	Placebo group Mean deviation (SD)	Test statistic	df	*p*
VC*	0.28 (0.01)	0.02 (0.00)	94.63$	44	<0.001
FVC**	0.22 (0.28)	-0.03 (0.04)	-5.87$$	-	<0.001
FEV1***	0.13 (0.00)	-0.01 (0.01)	61.16$	44	<0.001
FEV1/FVC	19.06 (15.57)	4.25 (14.09)	-2.97$$	-	<0.003
PEF****	0.04 (0.47)	-0.90 (0.07)	94.63$	44	<0.001
FEF25-75*****	2.25 (10.11)	-0.11 (0.27)	-2.97$$	-	<0.001
SPO_2******	2.43 (1.19)	0.47 (1.95)	-3.27$$	-	<0.05
RR*******	-2.78 (1.12)	-0.04 (10.11)	-4.92$$	-	<0.001

*Vital Capacity. **Force Vital Capacity. ***Forced Expiratory Volume in First Second. ****Pick Expiratory Flow Rate. *****Forced Expiratory Flow at 25%-75%. ******Blood Oxygen Saturation. *******Respiration Rate. $Independent *t*-test. $$Mann–Whitney

study that local hyperthermia reduces pain and stiffness caused by knee osteoarthritis and improves body function. Therefore, the results of current studies confirmed the positive effect of hyperthermia on respiratory indices.

Bito *et al*.[18] conducted a study aimed to investigate the immediate effects of hyperthermia on Chest Wall Mobility (CWM) and respiratory function. In this study, a hot pack increased only the tenth rib excursion which could not change respiratory functions. The hyperthermia with the hot pack was performed only once for 15 min. According to the researchers, the small sample size and short duration of the intervention were limitations of this study. In our study, thermotherapy was used for 23 min, twice a day and every 12 h, and the sample size was 46 people. Therefore, this difference in the results can be in terms of the difference in the duration of intervention and the number of studied people. Nutritional problems are also one of the common problems in patients with COPD, which is related to respiratory indices.[24] These patients develop gastrointestinal dysfunction due to short breathing, heaviness, problem breathing after eating food, and the inability in sufficient absorption caused by these disorders leads to weight loss, fatigue, weakness, and activity intolerance.[25] Sadeghian *et al*.[16] showed in one study that local hyperthermia affects gastrointestinal function in patients undergoing nasogastric tube feeding. According to this scientific finding, although we did not examine the nutritional status of the patients, based on the results of our study on the improvement of respiratory parameters, it can be expected that the improvement of nutrition and the resulting energy levels have also occurred in our study. Therefore, this study supports the results of the current study. Besides, Mohammadian *et al*.[20] stated that local hyperthermia with a hot pack causes calmness and decline in the anxiety of patients with acute coronary syndrome. They concluded that breathing and oxygen flow are improved following local hyperthermia with a hot pack. Mohammadpour *et al*.[11] found in their study that local hyperthermia in anterior chest improves breathing and percentage of blood oxygen saturation. The researchers in this study stated a decrease in pulmonary vessels resistance and their dilation, and also an increase in cardiac output following hyperthermia in justifying an increase in percentage of oxygen saturation and improvement of breathing. Due to the direct relationship between pulmonary circulation and respiratory status of patients.[20] The improvement of pulmonary vessel function following hyperthermia improves oxygen exchange and subsequently increases oxygen saturation percentage.

Although the study population in these studies is different, its results show positive effects of hyperthermia on vital organs and the possibility of using it even in acute and urgent situations. In addition, in most studies mentioned similar to the current study, hyperthermia of the anterior chest was done, and as the heart and lung are close to each other, and their actions are dependent on each other, these studies can support the results of the current study.

Study results by Kikuchi *et al*.[14] showed that systemic hyperthermia at a temperature of 60°C is effective in spirometry parameters, exercise enduring, and pulmonary function of the patient with COPD and can improve the obstruction of airways. According to the study, the changes in VC, PEF, and FEF50 were significantly higher in the intervention group than in the control group. They believed a larger improvement of VC, PEF, and FEF50 after repeated Waon therapy in their results was speculated to result from the suppression of airway inflammation and the alleviation of airway obstruction after repeated Waon therapy; the expansibility of lung parenchyma might also be heightened. It can be said that local hyperthermia can dilate the vessels via the increase in vessels' blood flow, removing inflammatory mediators, and stimulating heat receptors in the skin and deeper tissues.[17] Hence, local hyperthermia in these patients improves vascular endothelial performance, increases the production of nitric oxide and as a result dilates vessels as well as bronchioles and improves lung function in this way.[13]

Kunbootsri *et al*.[26] concluded in their study that the 6 weeks of repeated sauna treatment could increase

FEV1 in patients with allergic rhinitis. They believed that the increase of bronchial smooth muscle endurance and strength from hyperthermia might improve the FEV1. Local hyperthermia can also cause the above mechanism similarly. Results of the study by Kunutsor *et al*.[15] showed that regular sauna bathing is related to a decrease in the risk of acute and chronic respiratory diseases. Other studies have shown that warming reduces fatigue, improves sleep, and maintains energy.[25,27,28] These conditions can also improve respiratory indicators.[29,30] Like what happened in the present study.

One of the limitations of this study is that it was not possible to apply blinding methods to the patients because they could easily detect heat. It is recommended to perform further studies with blinding.

Conclusion

Local hyperthermia improves respiratory indices. These findings are clinically important in nursing care as the improvement of these indicators without using drugs is counted as an important care aim. Therefore, by considering the high prevalence of these patients in all the societies, in case the results of the present study on the effect of local hyperthermia on reducing fatigue among patients with COPD are confirmed in more extensive studies, it can be used as a safe, noninvasive, and cost-effective intervention. This way provides an opportunity for the medical team, especially nurses, to have better care for these patients.

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Conflicts of interest

Nothing to declare.

References

1. Duan R-R, Hao K, Yang T. Air pollution and chronic obstructive pulmonary disease. Chronic Dis Transl Med 2020;6:260-9.
2. Yohannes AM, Junkes-Cunha M, Smith J, Vestbo J. Management of dyspnea and anxiety in chronic obstructive pulmonary disease: A critical review. J Am Med Dir Assoc 2017;18:1096.e1-.7.
3. Chegeni PS, Gholami M, Azargoon A, Pour AHH, Birjandi M, Norollahi H. The effect of progressive muscle relaxation on the management of fatigue and quality of sleep in patients with chronic obstructive pulmonary disease: A randomized controlled clinical trial. Complement Ther Clin Pract 2018;31:64-70.
4. Montserrat-Capdevila J, Marsal JR, Ortega M, Castañ-Abad MT, Miquel A, Ferran B. *et al*. Clinico- epidemiological characteristics of men and women with a new diagnosis of chronic obstructive pulmonary disease: A database (SIDIAP) study. BMC Pulm Med 21, 44 (2021). doi.org/10.1186/s12890-021-01392-y.
5. Spruit MA, Vercoulen JH, Sprangers MA, Wouters EF. Fatigue in COPD: An important yet ignored symptom. Lancet Respir Med 2017;5:542-4.
6. Bajestani HS, Seyed Ali Javad Mousavi, Rezaei SZ, Shooshtary MH, Araby M. Relation of serum Vitamin D level and pulmonary punction in COPD patients. Razi J Med Sci 2015;22:35-40.
7. Hosseinzadeh Yonesi E, Mircheraghi F, Mohammdzadeh Moghadam H, Mojalli M. Effect of thymus vulgaris inhaling on wheezing and respiratory rate in patients with acute exacerbation of chronic obstructive pulmonary disease. Qtly Horiz Med Sci 2018;24:29-34.
8. Keyhanmanesh R, Ahmadi M, Jeddy S, Bagban H, Mirzaei Bavil F, Alipour MR, *et al*. Effect of vitamin C on tracheal responsiveness and pulmonary inflammation in chronic obstructive pulmonary disease model of guinea pig. Physiol Pharmacol 2013;17:101-15.
9. Jokar Z, Mohammadi F, Khankeh H, Rabiee Z, Falah Tafti S. Effect of home-based pulmonary rehabilitation on daily activity of patients with chronic obstructive pulmonary disease. Evid Based Care 2015;4:69-76.
10. Shahpasand M, Mohammadpour A, Najafi S, Sobhani M. The effect of local heat therapy on fatigue among patients with chronic obstructive pulmonary disease: A randomized controlled clinical trial. NPT 2020;8:123-31.
11. Mohammadpour A, Mohammadian B, Basiri Moghadam M, Nematollahi MR. The effects of topical heat therapy on chest pain in patients with acute coronary syndrome: A randomised double-blind placebo-controlled clinical trial. J Clin Nurs 2014;23:3460-7.
12. Sobajima M, Nozawa T, Shida T, Ohori T, Suzuki T, Matsuki A, *et al*. Repeated sauna therapy attenuates ventricular remodeling after myocardial infarction in rats by increasing coronary vascularity of noninfarcted myocardium. Am J Physiol Heart Circ Physiol 2011;301:H548-54.
13. Mirzaei F, Khazaei M. Role of nitric oxide in biological systems: A systematic review. J Maz Univ Med Sci 2017;27:192-222.
14. Kikuchi H, Shiozawa N, Takata S, Ashida K, Mitsunobu F. Effect of repeated Waon therapy on exercise tolerance and pulmonary function in patients with chronic obstructive pulmonary disease: A pilot controlled clinical trial. Int J Chron Obstruct Pulmon Dis 2014;9:9-15.
15. Kunutsor SK, Laukkanen T, Laukkanen JA. Sauna bathing reduces the risk of respiratory diseases: A long-term prospective cohort study. Eur J Epidemiol 2017;32:1107-11.
16. Sadeghian S, Mohammadpour A, Salari M. The effect of local heat therapy on gastric residual volume and abdominal distention in patients with nasogastric tube feeding: A randomized controlled clinical trial. J Hayat 2019;25:39-55.
17. Mohammadpour A, Mohammadian B, Basiri Moghadam M, Nematollahi MR. The effect of local heat therapy on physiologic parameters of patients with acute coronary syndrome: A randomized controlled clinical trial. J Crit Care Nurs 2014;7:74-83.
18. Bito T, Suzuki Y, Kajiwara Y, Zeidan H, Harada K, Shimoura K, *et al*. Effects of deep thermotherapy on chest wall mobility of healthy elderly women. Electromagn Biol Med 2020;39:123-8.
19. Johnson J. What is the average age for COPD? Medical News

Today. 2018. Available from: https://www.medicalnewstoday.com/articles/323350. [Last accessed on 2020 Feb 23].

20. Mohammadian B, Mohammadpour A, Nematollahi MR, Jamiati E. The effects of local heat therapy in the posterior part of chest on physiologic parameters in the patients with acute coronary syndrome: A randomized double-blind placebo-controlled clinical trial. Sci J Kurd Univ Med Sci 2017;22:72-81.
21. Sasaki N, Meyer MJ, Eikermann M. Postoperative respiratory muscle dysfunctionpathophysiology and preventive strategies. Anesthesiology 2013;118:961-78.
22. Kim K, Reid BA, Casey CA, Bender BE, Ro B, Song Q, *et al*. Effects of repeated local heat therapy on skeletal muscle structure and function in humans. J Appl Physiol 2020;128:483-92.
23. Yıldırım N, Filiz Ulusoy M, Bodur H. The effect of heat application on pain, stiffness, physical function and quality of life in patients with knee osteoarthritis. J Clin Nurs 2010;19:1113-20.
24. Mete B, Pehlivan E, Gülbaş G, Günen H. Prevalence of malnutrition in COPD and its relationship with the parameters related to disease severity. Int J Chron Obstruct Pulmon Dis 2018;13:3307-12.
25. Tajvidi M, Arash M, Parsinia M, Babaee G. Assessing the effects of nutritional guideline education on spirometric tests in patients with COPD. Iran J Nurs Res 2010;4:53-9.
26. Kunbootsri N, Janyacharoen T, Arrayawichanon P, Chainansamit S, Kanpittaya J, Auvichayapat P, *et al*. The effect of six-weeks of sauna on treatment autonomic nervous system, peak nasal inspiratory flow and lung functions of allergic rhinitis Thai patients. Asian Pac J Allergy Immunol 2013;31:142-7.
27. Economou N-T, Ilias I, Velentza L, Papachatzakis Y, Zarogoulidis P, Kallianos A, *et al*. Sleepiness, fatigue, anxiety and depression in chronic obstructive pulmonary disease and obstructive sleep apnea-overlap-syndrome, before and after continuous positive airways pressure therapy. PLoS One 2018;13:e0197342.
28. Sawatari H, Nishizaka MK, Miyazono M, Ando S-I, Inoue S, Takemoto M, *et al*. Three nights leg thermal therapy could improve sleep quality in patients with chronic heart failure. Heart and Vessels 2018;33:155-62.
29. Najafi Mehri S, Pashandi S, Mahmoodi H, Ebadi A, Ghanei M. Assessment of fatigue and spirometery parameters in chemical war victims with respiratory disease. Iran J War Public Health 2010;2:29-35.
30. Mohammadpour A, Amini S, Shakeri MT, Mirzaei S. Comparing the effect of open and closed ndotracheal suctioning on pain and oxygenation in post CABG patients under mechanical ventilation. Iran J Nurs Midwifery Res 2015;20:195-9.