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The Effect of Salt Space on Clinical Findings and Peak Expiratory Flow in Children with Mild to Moderate Asthma: A Randomized Crossover Trial

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ABSTRACT

The asthma treatment and control might be associated with significant burden on family and community, thus exploring other therapeutic plans could be desirable. The aim of this study was to investigate the effect of salt space on clinical findings and peak expiratory flow rate among children with asthma.

In this randomized crossover trial, 34 patients aged 6-14 years old with mild to moderate asthma were selected and randomly divided into two groups. The first group went through a period of salt therapy by staying in the salt room for one hour, three times a week for 3 consecutive weeks and then was under observation for three weeks. This process was reversed for the second group (three weeks under observation followed by salt therapy). The wash-out period was one week. During the study, the morning and evening peak expiratory flow (PEF), the frequency of coughing, wheezing, dyspnea and use of rescue medications were measured.

Salt therapy had a significant effect on raising the morning and evening PEF in the second week in both groups (p=0.028 and p=0.032, respectively). However, there was no significant effect on PEF variabilities, cough, wheezing, dyspnea, and the frequency of rescue medication (p>0.05). No side effect was observed during salt therapy.

This study showed the significant effect of salt therapy on PEF rate of the patients in the second week. However, further studies with different frequency and time of salt therapy on respiratory disorders are recommended.

Keywords: Asthma; Children; Peak expiratory flow rate (PEFR); Salt; Therapy

INTRODUCTION

Asthma is a chronic inflammatory disease characterized by: nonproductive coughs, dyspnea and wheezing. It is the most common chronic disease in childhood and it is the most common cause of children's absence from school [1, 2]. Asthma is a serious health problem with significant burden not only in health care costs, but also of loss productivity and reduced participation in family life [1,3]. Recent studies showed that more than ten percent of children and adolescences in our area suffered from asthma

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symptoms. [4,5] Thus improvement and control of the disease with alternative recourses in addition to standard therapy may be desirable.

Being in salt space is a treatment mehtod in which patients are placed in a controlled air medium similar to natural salt cave microclimate. It seems that the salt in the air affects the lining of the airways and relaxes the bronchial smooth muscles. Salt also can dilute the thick mucus in the lungs. [6,7]

Speleotherapy or staying in salt cave or salt mines have been done in Russia and Eastern Europe, but recently similar spaces and salt rooms or cabins were made and used in other parts of the world [8-11]. Some studies have shown the effectiveness of therapy in upper airway disorders, skin repair and even improvement of growth. [9,11-13] However, there were limited studies about effectiveness of this type of therapy. [8,14] To the best of our knowledge, this is the first study in Iran (at Zanjan province, which is rich in salt mines), to investigate the effect of salt therapy on Asthma. The aim of this study was to assess the effect of salt space on clinical findings and peak expiratory flow in children with mild to moderate asthma.

MATERIALS AND METHODS

This randomized crossover trial was carried out on children aged 6-14 years old with mild to moderate asthma on the bases of National Asthma Education and Prevention Program (NAEPP) Guideline[15]. These patients were selected from allergy clinic located at Mousavi Hospital (Zanjan, Iran). Children with acute febrile respiratory disease, chronic disease such as cystic fibrosis and congenital heart disease and history of hospitalization due to asthma attack in the previous 3 months were excluded from the study.

A room in the department of cultural heritage, handicrafts and tourism branch of Zanjan was chosen for making a salt room similar to salt caves. The room was prepared with the cooperation of the architectural department of Zanjan University and was 16 meters long, 2 meters wide and (in average) 2.1 meters in high. All surfaces (walls, roof and floor) were covered with salt, extracted from the salt mines of Chehrabad and Douzkand in Mahneshan, Zanjan. (Table 1) The diameter of salt on the walls was 1-1.5 centimeters. To cover the floor, large pieces of salt rock were chopped into small pieces and were then spread on the ground.

A salt inducer was used to feed the air in the room (Salin plus, Buzau, Romaina). The room covered by the device was 150 cubic meters and output was between 8-32 milligrams per cubic meter per hour (adjustable). Because of stable weather conditions in summer and schools being closed in this time, this trial began in June 2014. Meetings were held for parents and their children to see the room and getting the peak flow meter from 60 children, who were selected and invited to the study. After obtaining written consent from the parents, 33 cases enrolled in the study. They were randomly divided into two groups of 18 children (the first group) and 15 children (the second group). The first group was asked to be in the salt space (the room covered with salt and fed with salt inducer) for one hour three times per week for three weeks, thereafter they were under observation. The second group was at home and out of the salt space for three weeks and was then placed in the salt space for three weeks in the same manner. The wash-out between two periods was one week. During the study, all cases were instructed to use the peak flow meter (Cipla, India) and to measure their peak expiratory flow (PEF) rates in the morning and evening and to fill out their checklists. The frequency of coughs, wheezing, dyspnea, and use of rescue medications were also recorded to their diary card and were assessed weekly. The treatment was administered at an average temperature of 23^0C (ranged 18-27^0C) and 40% relative humidity (ranged 25-51%). During the treatment, the mean salt concentration of the air of the salt room was about 10 mg/m^3 (ranged 0-31.5 mg/m^3). This trial was submitted in Iranian Clinical Registry (ID: IRCT138812222976N3).

Table 1. Components of used salt samples from salt mines (amounts are expressed as percentages)

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MgO	CaO	Na^+	K_2O	Cl^-	SO_3	O.I*
Sample1	0.68	n.d	0.11	0.01	n.d	2.16	35.48	0.68	53.65	4.13	1.03
Sample2	0.68	n.d	0.08	0.009	n.d	5.3	32.46	0.53	50.10	7.5	3.17

(O.I= other elements, n.d= negligible)

Table 2. Baseline characteristics of the patients enrolled in the evaluation of effect of salt space on clinical findings and peak expiratory flow in Asthma

Variables	Salt therapy first* (n=18)	Salt therapy second§ (n=15)	*p*
Age (years, M±SD)	9.28± 2.4	10.33± 2.1	0.2¥
Gender n (%)			
Male	14(77.8)	7 (46.7)	0.08£
Female	4(22.2)	8 (53.3)	
Asthma severity n (%)			
Mild intermittent	8(44.4)	8 (53.3)	0.2£
Mild persistent	9 (50)	4 (26.6)	
Moderate	1 (5.5)	3 (20)	

*Salt therapy first: Underwent salt therapy during the first 3 week-period.

§Salt therapy second: Underwent salt therapy during the second 3 week-period.

¥ Independent T-test. £ Fisher's Exact Test.

Statistical Analysis

Values were expressed as mean±standard deviation, and number (percentage). Baseline characteristics were compared between treatment groups using chi-square test. Potential carryover effects were determined by independent t-test. Treatment effects on PEF were analyzed using a general linear model for repeated measures procedure, with time as within-subjects and between-subjects factors. Pairwise comparisons were performed by Bonferroni test. Treatment effects on clinical signs were analyzed using Cochran's Q test. Data were analyzed using the Statistical Package for the Social Sciences software program SPSS 16 (version 16; SPSS Inc., Chicago, IL USA)

RESULT

Baseline Characteristics

Thirty three children with asthma completed the study. 18 and 15 children randomly assigned to the first and second group and received salt therapy in the first and the second 3-weeks period, respectively. The age of children was between 6 and 16 years. The mean age of children were 9.28±2.4 and 10.33± 2.1 in the first and the second group, respectively (p= 0.2). Two groups were similar regarding gender and the severity of asthma. (Table 2)

Carryover Effects and Sequence Analysis

Assessment of the carryover effect for the morning and evening PEF showed no significant differences between two periods (Table 3). The morning and evening mean PEF in the first and the second period (for 33 subjects) from the first to the third week was not statistically different (Table 4). However, pairwise comparison of the morning and evening mean PEF between the first and the second week in two sequences with Bonferroni test was significantly different (p=0.028 and p=0.032, respectively). The effect of the sequence or the interaction between time and sequence for both the morning and evening PEF were not significant. No difference was observed for the morning and evening PEF variabilities in the first and the second sequence from the first to the third week using Huynh-Feldt test (p=0.36).

Table 3. The mean peak expiratory flow (PEF) of patients with asthma in the first 3 week- and second 3 week-period of salt space therapy

Variables	First sequence (n=33) M±SD	Second sequence (n=33) M±SD	*p*
Morning PEF (L/min)	224.7± 73.4	229±75.8	0.81¥
Evening PEF (L/min)	226.6± 72.5	230.9± 75.8	0.82¥

¥ Independent T-test.

Table 4 The mean peak expiratory flow (PEF) of patients with asthma in the first and second sequence of salt space therapy

Variables	First sequence (The first group in the salt room, second group at home) (n=33) M±SD	Second sequence (The first group at home, second in the salt room) (n=33) M±SD	*p*
Morning PEF (L/min)			
First week	221.08± 75.6	226.1± 76.7	0.057¥
Second week	225.4± 75.5	231.1± 77.5	
Third week	227.7± 70.8	230.4± 76.5	
Evening PEF (L/min)			
First week	222.1± 73.4	229.3± 76.7	0.167¥
Second week	229.09± 74.1	231.5± 76.3	
Third week	228.7± 71.8	231.9± 79.08	

¥ Repeated Measure, Huynh-Feldt test.

Comparison between Two Groups in the First and Second Sequence

In the first sequence (the first group in the salt room and the second group at home), the morning mean PEF from the first to third week has raised for both groups, but was not statistically significant (p=0.073); however, this difference for the evening PEF was significant (p=0.035). The PEF variabilities in the first sequence, from the first to third week was not significantly different, p=0.250, but PEF variability between two groups was significant (p=0.001) (the data are not shown).

In the second sequence (the first group at home and the second in the salt room), the morning and evening mean PEF from the fourth to sixth week for both groups was not statistically different (p=0.348 and p=0.756, respectively). The PEF variabilities in the second sequence, from the fourth to sixth week was not significantly different (p=0.763) (the data are not shown).

The morning mean PEF from the first to sixth week for both groups are shown in Figure 1. There was rising of PEF from first to third week during salt therapy. The morning mean PEF for the first group (salt therapy first) has increased from 210.9 at the first to 223.1 at the third week and for the second group (home first) has increased from 248.1 at the third to 251.7 at the sixth week; however, this increment was not statistically significant (p=0.098). The evening mean PEF from the first to sixth week for both groups was not significantly different (p=0.17). There were no significant changes in the frequency of cough, wheezing, dyspnea and rescue medication for both groups during consecutive weeks (Table 5).

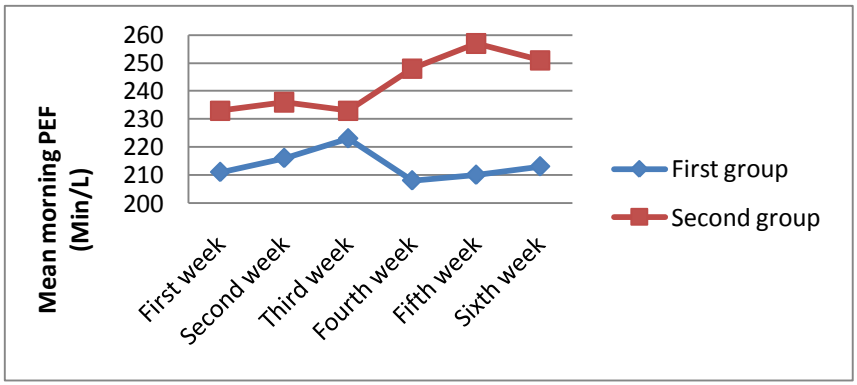

Figure 1. Comparison of theme an morning peak expiratory flow (PEF) between fist salt therapy (n=18) and second salt therapy (n=15) groups during evaluation of salt space effect on clinical findings of asthma

Table 5. Comparison of asthma clinical findings of the first and second salt therapy groups in consecutive weeks

Variable	First group(n=18)			Second group(n=15)		
	Yes	No	$p^{¥}$	Yes	No	$p^{¥}$
Coughs, number (%)	**Salt-exposed period**			**Salt non-exposed period**		
First week	10(55.6)	8(44.4)	0.074	7(46.7)	8(53.3)	0.37
Second week	9(50)	9(50)		8(53.3)	7(46.7)	
Third week	6(33.3)	12(66.7)		8(53.3)	7(46.7)	
	Salt non-exposed period			**Salt-exposed period**		
Fourth week	11(61.1)	7(38.9)	0.07	5(33.3)	10(66.7)	0.82
Fifth week	8(44.4)	10(55.6)		5(33.3)	10(66.7)	
Sixth week	6(33.3)	12(66.7)		4(26.7)	11(73.3)	
Wheezing	**Salt-exposed period**			**Salt non-exposed period**		
First week	3(16.7)	15(83.3)	1	3(20)	12(80)	0.71
Second week	3(16.7)	15(83.3)		2(13.3)	13(86.7)	
Third week	3(16.7)	15(83.3)		2(13.3)	13(86.7)	
	Salt non-exposed period			**Salt-exposed period**		
Fourth week	3(16.7)	15(83.3)	0.24	2(13.3)	13(86.7)	0.36
Fifth week	4(22.2)	14(77.8)		2(13.3)	13(86.7)	
Sixth week	1(5.6)	17(94.4)		1(6.7)	14(93.3)	
Dyspnea	**Salt-exposed period**			**Salt non-exposed period**		
First week	4(22.2)	14(77.8)	0.09	0(0)	15(100)	0.09
Second week	5(27.8)	13(72.2)		3(20)	12(80)	
Third week	2(11.1)	16(88.9)		2(13.3)	13(86.7)	
	Salt non-exposed period			**Salt-exposed period**		
Fourth week	3(16.7)	15(83.3)	0.60	3(20)	12(80)	0.71
Fifth week	2(11.1)	16(88.9)		3(20)	12(80)	
Sixth week	3(16.7)	15(83.3)		2(13.3)	13(86.7)	
Rescue medication	**Salt-exposed period**			**Salt nonexposed period**		
First week	5(27.8)	13(72.2)	0.05	1(6.7)	14(93.3)	0.36
Second week	3(16.7)	15(83.3)		2(13.3)	13(86.7)	
Third week	1(5.6)	17(94.4)		1(6.7)	14(93.3)	
	Salt non-exposed period			**Salt-exposed period**		
Fourth week	3(16.7)	3(16.7)	0.6	2(13.3)	13(86.7)	0.36
Fifth week	2(11.1)	2(11.1)		2(13.3)	13(86.7)	
Sixth week	3(16.7)	3(16.7)		1(6.7)	14(93.3)	

¥ *p* values are based on Cochran's Q tests results.

DISCUSSION

In this study, a 3-week salt-room treatment as an add-on therapy and a 3-week follow up were done for 33 children aged 6-14 years with mild to moderate asthma. we found that, being in the salt space had a significant effect on increasing the morning and afternoon PEF in the second week; however, this variability did not change significantly at the third week .

A similar study by Abdullaev et al., that evaluated the effect of salt cave staying in asthmatic children and showed the improvement of clinical findings, immunological parameters and pulmonary functions in children with atopic asthma.[6] However, in our study clinical findings such as wheezing, cough, Dyspnea was not significantly changed.

Another study illustrated that salt therapy resulted in improvements of clinical state in the most of the patients. The positive dynamics of flow-volume loop parameters and reduction of bronchial resistance measured by body pletismography were observed. The specificity of this method was the low concentration and gradual administration of dry sodium chloride aerosols to the space.[10] These findings indicated the benefits of a specific air dispersive environment of sodium chloride in treatment of the respiratory diseases. Meanwhile our study showed improvement of PEF, with no significant changes in clinical findings. It might be due to limited time and short course of salt therapy in our children in comparison with similar studies. It seems that the frequency and period of salt therapy in addition to using salt space instead of salt cave could make differences in these results.

Hedman J. et al illustrated the effectiveness of salt chamber treatment as an add-on therapy to low to moderate inhaled steroid therapy in asthma patients with bronchial hyper-responsiveness. After a 2-week baseline period, 32 asthma patients were randomized: 17 to the 2-week active treatment, during which salt was fed to the room by a salt generator, and 15 to placebo. The salt chamber treatment lasted 40 min and was administered five times a week. Median provocative dose causing a decrease of 15% in forced expiratoty volume in one second (FEV1) increased significantly in the active group but not in the placebo group. The difference in changes between the active and placebo group was significant. In their study salt chamber reduced bronchial hyper-responsiveness as an add-on therapy.[16] Our sample size and duration of salt space treatment were the same as their study, but our study had a crossover design and was performed on children. Unlike our study, PEF in their study was not increased significantly.

Several studies were carried out on obstructive pulmonary disorders in adults. Some of them indicated the improvement of lung function, distance walking and quality of life.[17,18] Rabbani and coworkers observed the positive effect of halotherapy in non-cyctic fibrosis bronchiectatic patients.[19] However, we did not find similar result. This may be affected by the low frequency of symptoms and severity of disease in our patients, and shorter period of therapy. However, the effect of salt therapy for respiratory disorders need to be assessed in longer period of time.[8, 14]

An experimental study by Xiao et al. showed that hydrogen-rich saline has reduced airway inflammation and remodeling in mice by inhibiting NF-Kb.[20] Another study demonstrated the effectiveness of salt therapy in improvement of immunologic status of patients.[21] However, the study of Sandell et al showed that salt chamber with different concentration of salt in space was ineffective in reduction of inflammation and eosinophile and neutrophil cell numbers.[22]

Some studies have shown the effectiveness of salt therapy in improvement of skin disorders and upper airway diseases.[9, 11, 12] In our study, interview with the children's mothers revealed that being in the salt room had a positive effect on decreasing their child's nasal congestion and resulted in comfortable breathing.

In spite of positive effect of salt space, a significant correlation between high salt intake and worsening of asthma has been reported. It has been shown that in some people with susceptible airway smooth muscle cells, a high salt intake would lead to reduced bronchodilatation mediated by β2 receptors.[23] Therefore, placing patients in salt space with high salt concentration should be performed with caution.

Our study indicated a significant increase in comparing the average morning and evening peak flow meter between the first and second weeks, but this comparison between the second and third week was not significant. The salt room did not have a significant effect on coughing, wheezing, dyspnea and the frequency of salbutamol using. It seems that salt therapy could be used as a complementary therapy for the treatment of asthma patients. Considering theF few number of samples in this study, more studies with a longer duration and more patients would be recommended; furthermore, considering the impact of temperature, humidity and salt density on the test result, a more controlled environment and more standard procedure are suggested. It would be also more effective to use the right dosage for future studies.

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REFERENCES

1. Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M, et al. Global strategy for asthma management and prevention: GINA executive summary. Eur Respir J 2008; 31(1):143-78.
2. Entezari A, Mehrabi Y, Varesvazirian M, Pourpak Z, Moin M. A systematic review of recent asthma symptom surveys in Iranian children. Chron Respir Dis 2009; 6(2):109-14.
3. Bitsko MJ, Everhart RS, Rubin BK. The Adolescent with Asthma. Paediatr Respir Rev 2013; 15(2):146-53.
4. Ahmadiafshar A, Ghoreishi A, Afkhami Ardakani S, Khoshnevis P, Faghihzadeh S, Nickmehr P. The high prevalence of depression among adolescents with asthma in Zanjan, Iran. Psychosom Med 2016; 78(1):113-4.
5. Ahmadiafshar A, Parchegani MR, Moosavinasab N, Koosha A. A Study of Relation between BCG Scar and Atopy in Schoolchildren of Zanjan City. Iran J Allergy Asthma Immunol 2005; 4(4):185-8.
6. Chervinskaya AV, Zilber NA. Halotherapy for treatment of respiratory diseases. J Aerosol Med 1995; 8(3):221-32.
7. Sandu I, Canache M, Vasilache V, Sandu IG. The effects of salt solions on the health of human subjects. Present Environment and Sustainable Development 2011; 5:67-88.
8. Beamon S, Falkenbach A, Fainburg G, Linde K. Speleotherapy for asthma. Cochrane Database Syst Rev 2001; 2:CD001741.
9. Lăzărescu H, Simionca I, Hoteteu M, Mirescu L. Speleotherapy - modern bio-medical perspectives. J Med Life 2014; 7:76-9.
10. Abdullaev AA, Gadzhiev KM, Eiubova AA. The efficacy of speleotherapy in salt mines in children with bronchial asthma based on the data from immediate and late observations. Vopr Kurortol Fizioter Lech Fiz Kult 1993; 5:25-8.
11. Khan MA, Chervinskaia AV, Mikitchenko NA. The use of halotherapy for the health improvement in children at institutions of general education. Vopr Kurortol Fizioter Lech Fiz Kult 2012; 2:31-5.
12. Gelardi M, Iannuzzi L, Greco Miani A, Cazzaniga S, Naldi L, De Luca C, et al. Double-blind placebo-controlled randomized clinical trial on the efficacy of Aerosal in the treatment of sub-obstructive adenotonsillar hypertrophy and related diseases. Int J Pediatr Otorhinolaryngol 2013; 77(11):1818-24.
13. Sandu I, Canache M, Sandu AV, Chirazi M, Mihaescu T, Checherita LE, et al. The influence of NaCl aerosols on weight and height development of children. Environ Monit Assess 2015; 187(2):15.
14. Rashleigh R, Smith SM, Roberts NJ. A review of halotherapy for chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 2014; 9:239-46.
15. NAEPP. (National Asthma Education and Prevention Program) Expert panel reports3: Guidelines for the diagnosis and management of asthma. J Allergy Clin Immunol 2007; 120(suppl):S94–S138.
16. Hedman J, Hugg T, Sandell J, Haahtela T. The effect of salt chamber treatment on bronchial hyperresponsiveness in asthmatics. Allergy 2006; 61(5):605-10.
17. Weinreich UM, Nilsson T, Mylund L, Christiansen HT, Laursen HS. Salt Halo Therapy and Saline Inhalation Administered to Patients with Chronic Obstructive Pulmonary Disease: A Pilot Study. J Palliat Care Med 2014; 4:1000185.
18. Cernomaz TA, Bolog SG, Mihăescu T. The effect of a dry salt inhaler in adults with COPD. Pneumologia 2007; 56(3):124-7.
19. Rabbani B, Makki SS, Najafizadeh K, Vishteh HR, Shafaghi S, Karimi S, et al. Efficacy of Halotherapy for Improvement of Pulmonary function Tests and Quality of Life of Non-Cystic Fibrosis Bronchiectatic Patients. Tanaffos 2013, 12(2):22-7.
20. Xiao M, Zhu T, Wang T, Wen FQ. Hydrogen-rich saline reduces airway remodeling via inactivation of NF-κB in a murine model of asthma. Eur Rev Med Pharmacol Sci 2013, 17(8):1033-43.
21. Nurov L. Immunologic features of speleotherapy in patients with chronic obstructive pulmonary disease. Medical and Health Science Journal 2010; 2(44–47).
22. Sandell J, Hedman J, Saarinen K, Haahtela T. Salt chamber treatment is ineffective in treating eosinophilic inflammation in asthma. Allergy 2013, 68(1):125-7.
23. Kotanko P, Skrabal F. Salt and asthma. BMJ 1994; 308(6927):537.