Observe Curative Effect of Functional Rehabilitation Training on Patients with Poor Pulmonary Function in Different Concentrations of Negative Oxygen Ions

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Abstract. Objective: observe the effect of air negative oxygen ion content on the elderly people who suffer from poor lung function and who receive deep breathing training. Methods: choose a total of 60 elderly people who are 65~75 years old and who suffer from poor lung function. They are randomly divided into three groups by the air negative oxygen ion intervention content level, for example, low content group, middle content group and high content group. The three groups of the selected patients adopt the same training methods for rehabilitation training. The air negative oxygen ion content is controlled to be $40\sim50/cm^3$ in the low content group(it is common value in the closed urban residential area); the air negative oxygen ion content is controlled to be $2000/cm^3$ in the middle content group(it is common value in the urban parks);the air negative oxygen ion content is controlled to be $200000/cm^3$ in the high content group(it is common value in the forest falls zone).The three groups of the selected people are trained for 30 minutes once a day. Such training lasts for 90 days. When they are selected and after 90 days' training, test and compare lung function indicators for three groups of the selected people. Results: after 90 days' training, the lung function indicators in the high content group obtain the best effect. Conclusion: air negative oxygen ion content plays an obvious intervention role in the effect of lung functional training. If the functional rehabilitation training occurs in the air environment with high negative oxygen ion content, it can significantly improve the respiratory muscle strength and lung function.

Introduction

China is stepping into the aging society. With the aging, the physical function of the elderly people gradually declines. The health of the elderly people has aroused widespread concern in society. The lung function declines attributable to declines of respiratory muscle, respiratory tract and alveolar elastic tension. It has been one of the important diseases damaging the body and mental health of the elderly people. Thus, it has important clinic and social significance to improve the lung function of the elderly people [1,2]. At present, it has been known and recognized that the lung function could be improved by the breath training and other physical intervention means. However, most of relevant results[3,4] are studied and analyzed from the aspect of training methods but the external factors, such as training environment, are given less attention. In the study, it focuses on the negative oxygen ion content, one of the important symbols to measure air quality, and discusses the effect of the negative oxygen ion content on the rehabilitation training. It is found in practice that the effect of rehabilitation training improves significantly with the increase of the negative oxygen ion content. It is reported as follows.

Data and Methods

Study objects. A total of 60 elderly people, male, 65-75 years old, who suffer from poor lung function, are chosen. Such selection excludes the patients with respiratory diseases and those

suffering from severe stroke or cardiovascular disease, who can't receive deep breathing training. The selected patients are examined for their lung function and then it is found that their indicators of lung function are significantly lower than the normal value. They are randomly divided into low content group, middle content group and high content group. Each group consists of 20 patients. Basic data for 3 groups of the selected patients is shown in Table 1. Upon the statistical comparison, *P>0.05*, the inter-group difference shows no statistics significance.

Table 1.　Comparison of Basic Data for 3 Groups of the Selected Patients（$\bar{x}$±s, male, n=20）

Groups	Age （year）	Body height （cm）	Body weight （kg）
Low content group	70.17±4.40	168.56±4.32	66.40±5.49
Middle content group	69.40±4.22	169.28±3.97	67.02±5.38
High content group	69.58±4.47	168.90±4.11	67.25±5.50

Note: *P＞0.05*.

　　Functional rehabilitation training method. The three groups of the selected people are trained for deep breathing for 30 minutes once a day. Such training lasts for 90 days. The specific contents are as follows: ①Preparatory postures. Approach: the trainees stand and place their hands on the upper abdominal and thoracic junction to take a deep breath for 2 minutes at slow or medium speed; Requirements: inhale the air as much as possible and then exhale it as much as possible; Objective: increase the lung ventilation volume and ventilation depth to promote air exchange, at the same time, improve extension adaptability of the thorax and lung muscle groups so as to prepare the shock contraction of anocoelia and lung muscle groups in strong intensity. ②Double up with laughter. Approach: the trainees stand and place their hands on the upper abdominal and thoracic junction to simulate and sustain laughter. In the laughing process, the chest muscle groups shock and contract to exhale deeply; Requirements: with the increase of the laughter depth and the exhaust depth, the subjects hold their abdomens with hands to stoop down and even crouch so as to discharge the lung gas. After that, take 1-2 deep breathing and natural breathing and double up laughter. Such repeated movements last for 5 minutes, during this process, the head shall not be dizzy; Objective: increase the exercise intensity of chest and abdominal muscle groups by imitating laughing, especially lung respiratory muscle groups. In the laughing, the chest, abdominal and lung muscle groups shock, which not only can improve the depth of deep breathing and exhaust, but also can increase contraction speed and strength of the muscle groups. ③Deeply breath and slowly exhale gas. Approach: the trainees stand and place their hands on the upper abdominal and thoracic junction to deeply inhale air at fast speed and then naturally or slowly exhale gas for 1-2 minutes rather than deep exhaust. Requirements: use mouth and nose to take deep breathing as fast as possible and inhale air as much as possible. Then use mouth and nose to exhale gas naturally without any additional force; Objective: exhale gas at fast speed to enhance the extension capacity of the chest, especially abdominal muscle group and pulmonary alveoli, and increase gas volume and gas exchange capacity of chest, abdomen and lung. Meanwhile, naturally inhale or slowly exhale air, which is beneficial to restore the muscle groups after laughing training. ④Natural breathing. Approach: the trainees stand and place their hands on the upper abdominal and thoracic junction to naturally breach for 1-2 minutes; Requirements: in the process of natural breathing, slightly increase the depth of breathing and it is proper if the trainees feel comfortable without a sense of compulsion; Objective: adjust and take a rest to relax thorax and lung muscle groups, meanwhile, the natural and comfortable deep breathing can increase the lung gas exchange capacity and guarantee the adequate oxygen supply of the human body. The training process: each training began from step ① and then circulate training in steps ②→③→④.

　　Negative oxygen ion intervention method. 3 groups of the selected people are trained for functional rehabilitation in different training rooms. Their exercise environments are same except

the air negative oxygen ion content levels. The air negative oxygen ion content is measured by air ion testing instrument; the content level is intervened by artificial negative oxygen ion generated by air negative oxygen ion generator. Air negative oxygen ion content is controlled in 40 ~ 50 /cm^3 in the low content group (it is common value in the closed urban residential area); the air negative oxygen ion content is controlled to be 2000/cm^3 in the middle content group(it is common value in the urban parks);the air negative oxygen ion content is controlled to be 200000/cm^3 in the high content group(it is common value in the forest falls zone).

Test lung function indicators. The relevant indicators of lung function for 3 groups of the selected people are tested when they are selected and after 90 days' training. Adopt RMS-II respiratory muscle function tester produced in China to test respiratory muscle strength. The main indicators include MIP (maximum inspiratory pressure); MEP (maximum expiratory pressure). Adopt SENSOR MEDICS-2200 lung function tester to test the lung ventilation function and the main indicators include SVC (slow vital capacity), FVC (forced vital capacity), FEV1 (forced expiratory volume in one second) and MVV (maximal voluntary ventilation). **Note:** MIP,MEP,SVC,FVC,FEV$_1$ and MVV are several important indicators associated with the human lung function and whether or not the measured values of such indicators are normal is related to the normally expected values of the subjects' age, gender, height and weight. MIP%, MEP%, SVC, %FVC,%FEV1 and %MVV values are ratio percentages between the measured values of the indicators and the normally expected value. The ratio of the measured value and the normally expected value reflects the lung function of the subject. The less ratio indicates more deviations the subject from the normal scope and the worse the lung function. Thus compare the subjects' MIP%, MEP%, %SVC, %FVC, %FEV$_1$ and %MVV values before and after the treatment and observe the improvement effect.

Data processing. Use SPSS17.0 statistical software package to process data. The available data is expressed in （$\bar{x}\pm s$）. Meanwhile, compare inter-group data before and after treatment and then improvement effect after treatment. Many inter-group comparisons are carried out by the variance analysis, while two inter-group comparisons are carried out by Dunnett-t, P<0.05, which indicates that the difference has the statistical significance.

Result

Improvement effect of respiratory muscle strength indicators before and after treatment. It can be known from Table 2 that after 3 groups of the selected people are trained and treated for 90 days, the respiratory muscle strength is improved to different extents in comparison with that before training, [a]$P＜0.05$. By comparing the improvement effect of all groups, it is found that the improvement effect of the respiratory muscle strength increases with the increase of the negative oxygen ion content and that of the high content group is best, respectively, [b]$P＜0.05$ or [c]$P＜0.05$.

Table 2. Testing and Comparing Respiratory Muscle Strength indicators for 3 Groups of the Selected People Before and After Treatment （$\bar{x}\pm s$, male, n=20）

Groups	%MIP		%MEP	
	Before treatment	After treatment	Before treatment	After treatment
Low content group	59.40±5.82	67.88±6.11[a]	62.39±5.74	70.54±5.60[a]
Middle content group	60.21±5.61	75.91±5.96[ab]	63.52±5.50	77.33±5.58[ab]
High content group	60.05±5.49	78.22±6.17[a]	62.48±5.72	82.24±6.02[ac]

Note: comparing with that before treatment, [a]P < 0.05; after treatment, comparing the improvement effect of the middle content group with the low content group, [b]P < 0.05; after treatment, comparing the improvement effect of the high content group with the middle content group, [c]P < 0.05.

Improvement effect of lung ventilation index before and after treatment. It can be known from Table 3 that after 3 groups of the selected people are trained and treated for 90 days, their lung ventilation indicators are improved significantly in comparison with that before training, [a]$P＜0.05$.

By comparing the improvement effect of all groups, it is found that the low content group, the middle content group and the high content group are improved but the improvement effect of the high content group is significantly superior to that of the low content group and the middle content group, respectively, [b]$P<0.05$ or [c]$P<0.05$.

Table 3(a). Testing and Comparing Lung Ventilation indicators for 3 Groups of the Selected People Before and After Treatment（x±s, male, n=20）

Groups	%SVC		%FVC	
	Before treatment	After treatment	Before treatment	After treatment
Low content group	62.73±5.20	74.30±6.13[a]	47.80±3.95	61.44±4.50[a]
Middle content group	63.59±5.37	78.75±6.20[ab]	47.61±4.02	69.70±4.72[ab]
High content group	63.14±5.40	82.10±6.17[ac]	48.20±4.13	73.51±4.59[ac]

Table 3(b). Testing and Comparing Lung Ventilation indicators for 3 Groups of the Selected People Before and After Treatment（x±s，male, n=20）

Groups	%FEV1		%MVV	
	Before treatment	After treatment	Before treatment	After treatment
Low content group	49.62±4.30	58.94±4.77[a]	53.59±4.81	69.80±5.36[a]
Middle content group	50.43±4.25	64.71±4.80[ab]	54.26±4.60	75.34±5.28[ab]
High content group	50.61±4.33	67.90±4.87[ac]	54.05±4.49	78.41±5.35[ac]

Note: comparing with that before treatment, [a]$P < 0.05$; after treatment, comparing the improvement effect of the middle content group with the low content group, [b]$P < 0.05$; after treatment, comparing the improvement effect of the high content group with the middle content group, [c]$P < 0.05$.

Discussion

Because the elderly person decline in lung function, they are prone to the breathing shortness. For this reason, they mainly use chest to breath in a fast and shallow means, which can't guarantee the effective alveolar ventilation, but also easily lead to respiratory muscle tension and increase oxygen consumption, as a result, it fatigues respiratory muscle and thus affects the lung function [5-7]. It is believed in the relevant study that with the decline of respiratory muscle contractility, elastic resistance of the lung and thorax and non-elastic resistance of respiratory tract are the important causes for the decline of the lung function among the elderly people [8-9]. In this study, FVC and FEV_1 are two indicators reflecting rapid breathing capacity. Comparing the measured value and the expected value, the decrease rate is much higher than SVC, which shows that the dynamic lung function(FVC) and FEV_1 decrease significantly. Among the lung function rehabilitation exercises like deep breathing gymnastics, if the deep laughing exercise can be added, it can greatly improve the exhaust depth in the deep breathing exercise. In laughing, contraction shock intensity, velocity and depth of the respiratory muscle groups in the chest and abdominal cavity, especially in the lung shock contraction and exhaust process, are significantly better than ordinary deep breathing. The rapid and deep breathing training will greatly increase the oxygen consumption and the full blood supply to the body requires the lung increase oxygen intake. Based on this, the air negative oxygen ion content is a focus in the study so as to observe the intervention effect of the air quality in the living environment, that is, the air negative oxygen ion content, on the function rehabilitation training.

In recent years, the effect of the air negative oxygen ion content on human health, has aroused widespread concern. WHO has already recognized the air negative oxygen ion content as one of the important criteria for evaluating air quality. It also can be seen from the current standards of major domestic and foreign sanatoriums and resorts that the air quality, that is, negative oxygen ion content, has been used as an important indicator. Air quality has attracted much attention from the people. For example, it is pointed out in the relevant study that [10,11]when the air negative oxygen ion content is less than 20 /cm^3, the people will feel tired and dizzy; when such content is

1000-10000/cm^3, the people will be in a calm mood; when it is more than 10000/cm^3, the people will feel refreshed and comfortable; if it is more than 100000 /cm^3, it can make the people keep in calm, stop panting, remove fatigue and regulate nerve disease. Thanks to the importance of negative oxygen ion in the human health, it is called as "air vitamin", "vita oxygen" and "longevity factor" in the medical field, from which it witnesses the beneficial effects on the human health .In this study, 3 groups of elderly people, who are trained for the lung function rehabilitation, are treated in the environments with different negative oxygen ion contents. After 90 days' training, it is found that the improvement effect of the relevant indicators, such as respiratory muscle strength and lung ventilation function, is enhanced with the increase of negative oxygen ion content and all testing indicators in the high content group obtain the best improvement effect. The mechanism should be related to the following factors: the high negative oxygen ion content can increase the oxygen intake exchanged with the lung, meanwhile, the adequate oxygen supply can improve the tolerance of human body exercise and delay the occurrence of exercise fatigue, but also it is conducive to maintain a good mental state of the human body and then improve the training effect[11-12]; In addition, the negative oxygen ions can enter into the body tissue with blood circulation and participate in the bio-electrical activity of the cells to charge the cell and then adjust the normalization of the cell membrane ion transport mechanism. In this way, it not only can enhance energy metabolism in cells and play an important role in maintaining the cell ion balance and improve the body's ability to repair itself [13-14].

In summary, this study suggests that air negative oxygen ion content level exercises an obvious intervention effect on lung function training. If the functional rehabilitation training occurs in the air environment with the high negative oxygen ion content, it can obviously improve respiratory muscle strength and lung ventilation function. It also suggests to the elderly people with poor lung function and lung dysfunction that it shall fully consider the intervention factors of the training environment in the function rehabilitation training process.

References

[1] Rossi AP, Watson NL, Newman AB, Harris TB, Kritchevsky SB, Bauer DC, Satterfield S, Goodpaster BH, and Zamboni M. Effects of body composition and adipose tissue distribution on respiratory function in elderly men and women: the health, aging, and body composition study. J Gerontol A Biol Sci Med Sci, Vol.66(2011) No.7, p.801-8.

[2] Pegorari MS, Ruas G, and Patrizzi LJ. Relationship between frailty and respiratory function in the community-dwelling elderly. Braz J Phys Ther, Vol.17(2013) No.1, p.9-16.

[3] Bezerra LA, de Melo HF, Garay AP, Reis VM, Aidar FJ, Bodas AR, Garrido ND, and de Oliveira RJ. Do 12-week yoga program influence respiratory function of elderly women? J Hum Kinet, Vol.43(2014) No.11, p.177-84.

[4] Q.H. Song, R.M. Xu, G.Q. Shen, Q.H. Zhang, M. Ma, X.P. Zhao, Y.H. Guo and Y. Wang. Influence of Tai Chi exercise cycle on the senile respiratory and cardiovascular circulatory function. Int J Clin Exp Med, Vol.7(2014) No.3, p.770-4.

[5] M. Zhang, S.H. Fu, H. Cui, B.P. Zhu, L. Liu, and D.L. Wang. Serum cystatin C and indices of lung function in elderly Chinese men with chronic obstructive pulmonary disease. Aging Clin Exp Res, Vol.26(2014) No.2, p.193-9.

[6] Miller MR, Thinggaard M, Christensen K, Pedersen OF, and Sigsgaard T. Best lung function equations for the very elderly selected by survival analysis. Eur Respir J, Vol.43(2014) No.5, p.1338-46.

[7] Hassel E, Stensvold D, Halvorsen T, Wisløff U, Langhammer A, and Steinshamn S. Association between pulmonary function and peak oxygen uptake in elderly: the Generation 100 study. Respir Res, Vol.16(2015) No.10, p.156.

[8] Giua R, Pedone C, Scarlata S, Carrozzo I, Rossi FF, Valiani V, and Incalzi RA. Relationship between respiratory muscle strength and physical performance in elderly hospitalized patients. Rejuvenation Res, Vol.17(2014) No.4, p.366-71.

[9] Chen YC, Cao JM, Zhou HT, Guo X, and Wang Y. The effect of loaded deep inhale training on

mild and moderate COPD smokers. Int J Clin Exp Med, Vol.7(2014) No.10, p.3583-7.

[10] Friedmann M, and Haber P. The influence of negative air ions on the regulation of respiration and blood circulation under controlled physical stress, as well as on reaction time (author's transl). Wien Med Wochenschr, Vol.132(1982) No.5, p.101-5.

[11] J. Lv, W. Wang, Krafft T, Y. Li, F. Zhang, and F. Yuan. Effects of several environmental factors on longevity and health of the human population of Zhongxiang, Hubei, China. Biol Trace Elem Res, Vol.143(2011) No.2, p.702-16.

[12] Nimmerichter A, Holdhaus J, Mehnen L, Vidotto C, Loidl M, and Barker AR. Effects of negative air ions on oxygen uptake kinetics, recovery and performance in exercise: a randomized, double-blinded study. Int J Biometeorol, Vol.58(2014) No.7, p.1503-12.

[13] Sirota TV, Safronova VG, Amelina AG, Mal'tseva VN, Avkhacheeva NV, Sofin AD, Ianin VA, Mubarakshina EK, Romanova LK, and Novoselov VI. Effect of negative air ions on respiratory organs and blood. Biofizika, Vol.53(2008) No.5, p.886-93.

[14] M. Ma, Q.H. Song, R.M. Xu, Q.H. Zhang, G.Q. Shen, Y.H. Guo, and Y. Wang. Treatment effect of the method of Tai Chi exercise in combination with inhalation of air negative oxygen ions on hyperlipidemia. Int J Clin Exp Med, Vol.7(2014) No.8, p.2309-13.