

A Study on Lung Function Activation of Sound Necklace

¹Bong-Young Kim, ²Ik-Soo Ahn and ¹Myung-Jin Bae

¹Information and Telecommunication Engineering,

²Department of Cultural Contents, SoongSil University, Sangdo-dong,
Dongjak-gu, Seoul, Korea

Abstract: Pneumonia is the fourth leading cause of death due to disease, following cancer, heart disease and cerebrovascular disease. Chronic obstructive pulmonary disease also occupies 6th place. In particular, the mortality rate is lower or slightly increased in other diseases while the mortality rate due to lung disease is increasing rapidly. Most of the ways to prevent lung disease are deviating from the polluted atmosphere. However, as fine dust increases and air pollution becomes more serious, aggressive lung health measures are needed to live a healthy 100 years old age. Sound necklace has been studied to increase the immunity of the lungs by activating the lungs through sound as a proactive and active measure. In this study, oxygen saturation, pulse rate measurement and MOS test were performed by stair climb with sound necklace. Through experimentation, we want to see if sound necklace is beneficial for the activation of lung function. Case to climb stairs without sound necklace showed more decreased oxygen saturation than case with sound necklace. And the MOS test, more than half said that breathing was smooth. Experimental results show that the sound necklace has been helpful in the activation of lung function.

Key words: Sound necklace, cause of death by disease, pneumonia, oxygen saturation, activation of lung function, experimentation

INTRODUCTION

According to the National Statistical Office's data released in 2015, pneumonia is the 4th cause of death after cancer, heart disease and cerebrovascular disease. In addition, chronic obstructive lung disease following diabetes is the 6th cause of death. Lung-related diseases occupy the 4th and 6th places, respectively. In particular, the number of deaths from respiratory system diseases including lungs has been steadily increasing year by year and the mortality rate is also steadily increasing. These lung diseases are very hard to recover once they are damaged and because they are difficult to live alone they often cause serious burdens on their families and their social costs are also rapidly increasing (Anonymous, 2006, 2016).

Lung is an organ that plays a role in exchanging oxygen and carbon dioxide through breathing more than 20,000 times a day. In this process, it plays a role of discharging not only carbon dioxide but also many toxic substances in our body. However, there are a number of obstacles that interfere with the ability of this lung to decipher and drop the lung function. Smoking and fine dust, polluted air, chemical cleaner bubbles, fungus and

house dust mite which are caused by industrial development are critical to lung health. In particular, toxic chemicals and toxic and fine dusts continuously weaken the immune function of our body which causes not only immune dysfunction but also fatal diseases such as lung fibrosis. A common way of keeping lung health known to us is to reduce the inflow of chemicals when breathing do not use chemical cleaners if possible and pay attention to fungus and house dust mites. The only way to overcome the passive is to overcome. However, our environment is an inevitable situation in which fine dusts are taking place and air pollution is getting worse but it is a very insufficient measure only by a passive method of avoiding harmful environment (Anonymous, 2018).

For those of us living in the age of 100, we need efforts to keep our lungs healthy to live up to 100 years of age. Sound necklace which stimulates the lungs directly by sound is being studied as a more active and aggressive measure to protect lung health. The sound necklace is a health aiding device developed to help the health of the wearer by detecting the sound component beneficial to the wearer's body through the voice of the wearer and analyzing the breathing pattern and voicing the wearer's body in the form of vibration and sound. A

person's neck is an important part of the body that connects the nerves, blood vessels and muscles of various parts of the body to the brain. The sound necklace which is worn on a person's neck, delivers various sound components to each part of the body through the neck. At this time, each part of the body is stimulated by the transmitted vibration and sound. In particular, the sound necklace can be used to activate the lung function by playing back the voice component of the wearer thus acting as a stimulus to the air duct and vocal through the vocal track and glottis (Ik-Soo and Myung-Jin, 2016; Myung-Jin, 2010; Bong-Young *et al.*, 2017; Kang *et al.*, 2017; Sueng *et al.*, 2011).

In this study, we examined the effect of sound necklace on the activation of the lung function through measurement of blood oxygen saturation change, pulse rate measurement and subject MOS test by stair climb experiment with sound necklace.

MATERIALS AND METHODS

Sound necklace

Principles of sound necklace: Every object resonates with its own frequency. This means that the object responds to the resonant frequency. As is well known in speech generation models, human voices are generated in harmonic form by several resonant frequencies due to the effects of complex human organs. Therefore, it can be said that the voice contains information of various parts of the body. The sound necklace analyzes the resonance frequency contained in a person's voice and vocalizes the voice back to the body. It was developed to help health through stimulation of each part of body. In particular, the sound necklace can be helpful in activating of lung function because it stimulates the lungs which are difficult to physically stimulate, to the sound component by analyzing the vocal components of the person and reversing them (Bae and Lee, 1998; Kang, 2007).

Sound component of sound necklace: For the sound necklace which was made considering the adult male wearer, we collected the sound source in the anechoic room and showed what sound component stimulates the neck of the wearer.

Figure 1 shows the wave form of the sound necklace and Fig. 2 is the frequency spectrum. As shown in Fig. 1, the sound necklace stimulates the neck by sounding for about 0.5 sec every 2.5 sec. Each frequency is stimulated by the intensity shown in Fig. The unusual point is that the frequency component of the frequency band of 100~200 Hz corresponding to the male fundamental Frequency (F0) range is about 30 dB higher than that of the other frequency band.

Blood Oxygen Saturation (SpO₂): One of the main functions of the blood is to supply oxygen from the lungs to the body tissues while transporting carbon dioxide to the lungs in the tissues. Blood hemoglobin is divided into 'Oxygenated Hemoglobin (HbO₂)' that is bound to oxygen and 'Deoxygenated Hemoglobin (Hb)' that is not bound to oxygen. At this time, blood oxygen saturation represents the ratio of oxygenated hemoglobin in the hemoglobin of the blood and expressed as Eq. 1:

$$\text{Oxygen saturation} = \frac{C(\text{HbO}_2)}{C(\text{HbO}_2)+C(\text{Hb})} \times 100(\%) \quad (1)$$

Where:

C(HbO₂) = Concentration of oxygenated hemoglobin

C(Hb) = Concentration of deoxygenated Hemoglobin

This blood oxygen saturation is used as a vital sign in hospitals next to pulse rate, body temperature, blood pressure and breathing. A device that measures this important indicator, blood oxygen saturation is called Pulse Oximeter. The Pulse Oximeter is designed to measure the severity of disease such as 'severity assessment of disease', 'blood gas analysis', 'home

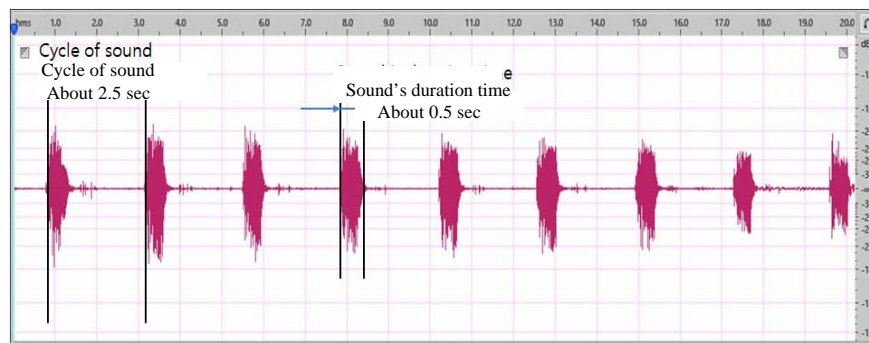


Fig. 1: Sound wave form of sound necklace

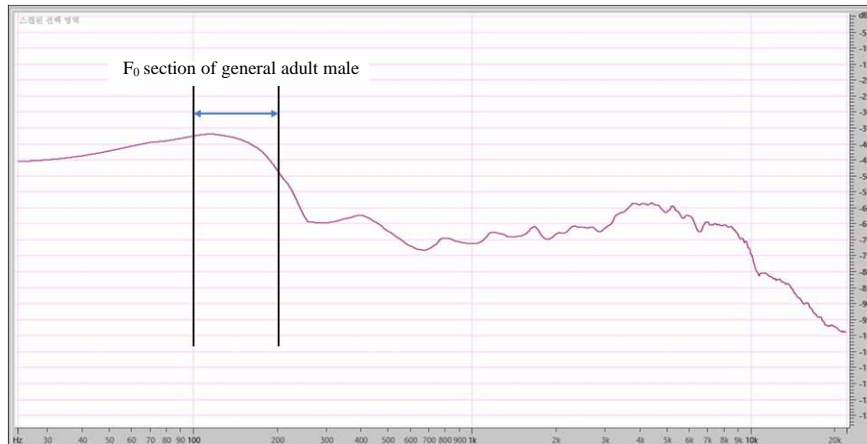


Fig. 2: Frequency spectrum of sound necklace

oxygen therapy’, ‘evaluation of respiratory rehabilitation’, ‘evaluation of respiratory function’, ‘observation of sleep apnea’ it is used for measurement and observation. Blood oxygen saturation is a measure of the lung function as it can confirm that the oxygen supply is active in the body. The principle of measurement of the pulse oximeter absorbs ‘oxygenated hemoglobin’ infrared rays while ‘deoxygenated hemoglobin’ absorbs more rays. The pulse oximeter emits Infrared (IR) and Red (R) radiation and hemoglobin absorbs and analyzes the remaining two wavelengths to measure oxygen saturation (Sueng *et al.*, 2011). Pulse oximeters are available in a variety of products depending on the application and precision. In this study, however, we used portable pulse oximeter with convenient mobility due to stair climb experiment.

RESULTS AND DISCUSSION

Experiments on activation of lung function for sound necklace were conducted in 8 healthy male adults between 20 and 40s. In the experiment, 8 adult males performed two stair climbs from the first floor to the 14th floor of the central staircase of Hyungnam Memorial Engineering Building, Soongsil University. At this time, one step was performed without a sound necklace and one time with a sound necklace. However, four people climbed the stairs first without the sound necklace and the other four people applied the sound necklace and climbed the stairs first. In this experiment, oxygen saturation and pulse rate were measured firstly using a pulse oximeter before the stair climb and then oxygen saturation and pulse rate were measured again after 4 sec after the stairs were ascended. For the participants, a separate MOS test was performed to see if the sound necklace helped breathing when climbing the stairs (Fig. 3).

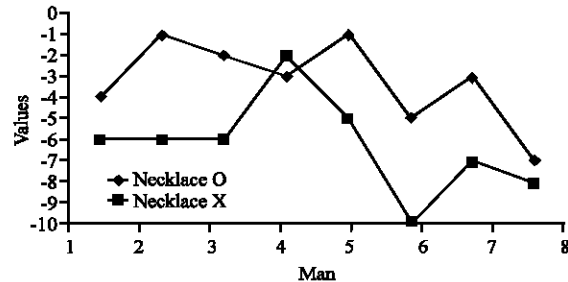


Fig. 3: Change of oxygen saturation according to wearing of sound necklace (increase/decrease)

Table 1 shows the experimental results of 8 men participating in the stair climb experiment. Experiment participants completed the stair climb with a difference of <10 sec between wearing the sound necklace and not wearing it. Regardless of the wearing of the sound necklace, oxygen saturation decreased and the pulse rate increased in the after climb rather than before climb.

Figure 3 shows the increase and decrease of oxygen saturation with and without sound necklace based on the experimental data in Table 1. In the case they were wearing a sound necklace than did not have a sound necklace, 7 out of 8 participants show that the decrease in oxygen saturation was small when participating in the experiment.

Figure 4 demonstrates that wearing a sound necklace in each experiment contributed to the breathing in the stair climb experiment in five steps (very helpful, helpful, not sure, uncomfortable, very uncomfortable) of the MOS test results. Five of the participants answered that they were helpful, two said they did not understand and one responded that they were uncomfortable with breathing and the MOS test had an average value of 3.6.

Table 1: Stair climb experiment result

Subjects	Whether to wear a sound necklace	Climb time (sec)	Before climb		After climb		PR (bpm)
			SpO ₂ (%)	PR (bpm)	SpO ₂ (%)	PR (bpm)	
Male-1	O	264	98	90	94	156	
	X	267	96	94	90	174	
Male-2	O	267	93	98	92	163	
	X	264	96	87	90	165	
Male-3	O	255	96	96	94	181	
	X	267	95	107	89	170	
Male-4	O	249	96	91	93	183	
	X	250	96	101	94	180	
Male-5	O	250	96	81	95	172	
	X	240	96	90	91	157	
Male-6	O	233	97	95	92	156	
	X	238	97	78	87	181	
Male-7	O	237	97	80	94	176	
	X	230	94	90	87	182	
Male-8	O	230	96	80	89	177	
	X	232	96	84	88	175	

SpO₂: Blood Oxygen Saturation (%); PR: Heart rate (bpm)

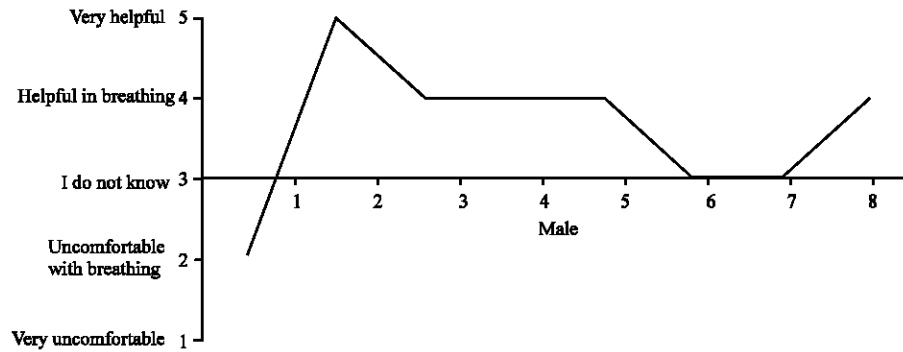


Fig. 4: MOS test results that sound necklace wear helped breathing

CONCLUSION

Smoking, fine dust and polluted air play a critical role in deteriorating our lung health, leading to a rapid increase in the mortality of pneumonia and other lung diseases. The most common way to prevent lung disease from being known to us is through a passive method of escaping air polluted environments. However, fine dust is increasingly becoming toxic and air pollution is getting worse. The development of medical technology, we live in a 100 years old we need to actively take care of lung health to live up to 100 years old. The sound necklace is being studied to analyze the voices of people and to resonate each part of the body to help health. The sound necklace is able to stimulate and activate the lungs by delivering a sound component that is beneficial to the wearer to the air duct and lung by reversing the voice component of the wearer which can be an active measure against lung health.

As a result of the experiment in the fourth chapter, the decrease of oxygen saturation was relatively less when the stair climb was performed with the sound

necklace than without the sound necklace. MOS test results of the participants also showed that more than half of them answered that breathing was more smooth than when they did not wear the sound necklace when wearing the sound necklace and stair climbing.

From these results, we concluded that the sound necklace activated the lungs through vibration and sound, effectively supplying oxygen. The results of this study show that there may be individual error of each participant and error of experimental environment but a lot of results show that sound necklace has helped the activation of lung function. This is a meaningful result of the activation of lung function effect as a health-care instrument being studied.

The neck is the most important part of the body and the sound necklace is a neck-wrapping health aid. Sound necklace has been studied to enhance immunity by stimulating many parts of the body through sound. We hope that the sound necklace will help us identify a number of health effects and we hope sound necklace will help the healthy life of humankind in the age of 100.

REFERENCES

- Anonymous, 2006. How to read SpO₂. Konica Minolta Business Solutions, Ramsey, New Jersey, USA.
- Anonymous, 2016. Report the cause of death in 2015. Statistics Korea, Korea.
- Anonymous, 2018. Lung body organs information. Seoul National University Hospital, Seoul, South Korea. <http://terms.naver.com>.
- Bae, M.J. and S.H. Lee, 1998. Digital Speech Analysis. Dong Young Diamond Industrial Co. Ltd., South Korea.
- Bong-Young, K., A. I k-Soo and B. Myung-Jin, 2017. A study on improvement of lung function through stimulation of sound necklace. Proceedings of the 5 th International Symposium on Advanced and Applied Convergence (ISAAC 2017), November 1-12, 2017, Dongguk University, Seoul, South Korea, pp: 195-198.
- Ik-Soo, A. and B. Myung-Jin, 2016. Study on a new sound necklace for a body fitness. Intl. Inf. Inst. Tokyo J. Inf., 19: 3737-3744.
- Kang, S.H., 2007. Fundamentals of sound engineering. Sound Media, Korea.
- Kang, S.H., S. H. Jung, H.K. Jung and J.W. Lee, 2010. Analysis of reverberation time. Acoust. Soc. Korea, 2010: 311-314.
- Myung-Jin, B., 2017. On a voice health technology. J. Acoust. Soc. Korea, 34: 3-4.
- Sueng, H.H., G.L. Soon, S.K. Jung, S.K. Pan and J.O. Byung, 2011. Influence of a difference in Oxygen intake concentration on recovery after performing maximum exercise. J. Korean Alliance Martial Arts, 13: 287-299.