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Study on the shouting breathing pattern while jogging wearing a mask

[1]Zhixing Tian, [2]Myung-Jin Bae*

[1,2] Prof., Soong-sil University, Department of Information and telecommunication Engineering, Soong-sil Univ., Korea
*zhixingt@soongsil.ac.kr, mjbae@ssu.ac.kr**

Abstract

Because of the COVID-19 epidemic, many countries have made the obligation to wear masks normal. Wearing masks in public places has become a must. At present, wearing a mask to participate in sports makes it very common. People seek to gain health through exercise but ignore the potential respirato-ry health threat. That is, wearing a mask will cause a decrease in oxygen content in the body. This neg-ative impact becomes more prominent as the wear-ing time and oxygen consumption increase. To pro-tect people from viruses and enjoy a healthy life. This paper proposes a breathing pattern that im-proves blood oxygen saturation while wearing a jogging mask and walking. Namely, shouting breathing pattern. Use a pulse oximeter to measure the blood oxygen saturation of running at different speeds and compare the normal breathing pattern and the shouting breathing pattern. The results show that the shouting breathing pattern has a sig-nificant improvement in the blood oxygen satura-tion of low-speed walking and medium-speed jog-ging.

Keywords: *COVID-19, Mask, Blood Oxygen Saturation, Jogging, Shouting Breathing Pattern.*

1. INTRODUCTION

With the spread of COVID-19, wearing masks can effectively prevent the spread of the pandemic virus has been proven so that most countries will make mask-wearing obligatory. Wearing masks in public has become a must. Although wearing a mask does not have much impact on ordinary people's lives. However, wearing a mask has a significant influence on sports. Sports will consume oxygen faster, while masks increase breathing resistance. The rapid consumption of oxygen in the body without replenishment will cause hypoxia. This is a reason that many studies do not recommend wearing a mask during strenuous exercise. However, many people choose to wear masks for walking, jogging, and other sports in the park. Because the exercise intensity and oxy-gen consumption are not significant, wearing a mask is not unbearable. However, studies have shown [1] that wearing a mask for jogging will decrease blood oxygen saturation. So, maybe these healthy exercises cannot bring health. People should also pay attention to their respiratory health. Finding a way to alleviate the decline in blood oxygen saturation can make people enjoy life better.

The main reason for the decrease in blood oxygen saturation is that the mask obstructs breathing. When air is inhaled, because the mask blocks the air, only part of it is inhaled. Similarly, when the air is exhaled, some carbon dioxide is trapped in the mask. Then it will be re-inhaled in the next breathing cycle. Insufficient intake of oxygen in the lungs leads to a decrease in blood oxygen saturation. People need to overcome breathing resistance, inhale more oxygen, and expel carbon dioxide as much as possible if people want to maintain blood

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Corresponding Author: mjbae@ssu.ac.kr
Tel:*** - **** - ****
Professor, Dept. of Telecomm. Engrn., Soongsil Univ., Korea

oxygen saturation. So, it is necessary to control the breathing pattern. [2]

This paper aims to study the breathing pattern that relieves the decrease in blood oxygen saturation when wearing a mask. Use the detection principle of the photoelectric pulse oximeter to detect the change of blood oxygen saturation. Further, prove the effectiveness of this breathing pattern. The 2 chapter explicitly introduces the shouting breathing pattern and explains its function in principle. The 3 chapter introduces the detection principle of blood oxygen saturation and pulse oximeter. Chapter 4 detects the normal breathing pattern's blood oxygen saturation and the shouting breathing pattern when wearing a mask and analysing the results. Chapter 5, Conclusion.

2. SHOUTING BREATHING PATTERN

2.1 Shouting breathing pattern method

The shouting breathing method is an improved method based on the vocal cord breathing method. In running, oxygen consumption increases, and breathing rate increases, resulting in a short expiration time of exhaled carbon dioxide. Most of the carbon dioxide remains in the mask. So shouting breathing improves the way of exhaling while retaining the way of inhaling. It requires the nose and mouth to inhale together, inhale for 3 seconds, and hold for 1 second. When exhaling, the air in the lungs flows through the vocal cords and vibrates, shouting out the slogan rhythmically, that is, "하나, 둘, 셋." Each Korean number pronunciation lasts for one second, and the shouting lasts for a total of 3 seconds. This breathing cycle is 7 to 8 seconds. The breathing rate of the breath per minute is 8-9 times. [3]

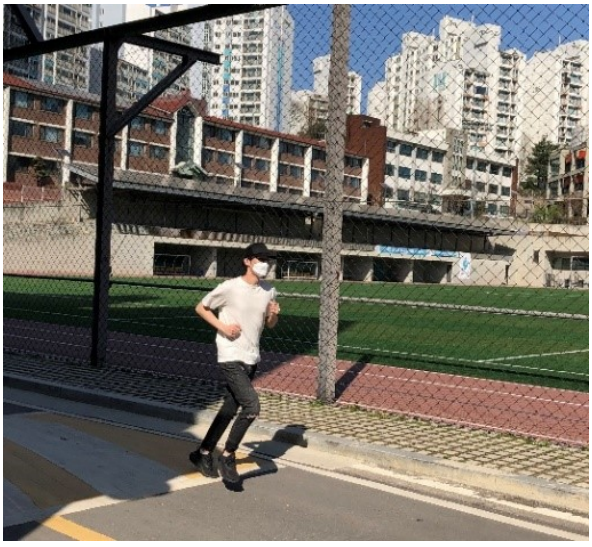

Figure 1. The subject wears a mask to jog

2.2 The principle of shouting breathing pattern to improve blood oxygen saturation

The most significant difference between the shouting breathing pattern and the normal vocal breathing pattern is that the vocalization is intermittent and rapid when exhaling. Using deep inhalation increases the intensity of inhalation and increases the gas flow rate to increase the oxygen permeability through the mask. Can increase the amount of oxygen inhaled. Similarly, the exhalation pattern of shouting is to speed up the diffusion of carbon dioxide. The yelling is made by compressing the gas through the vocal cords. The flow rate of the gas is instantaneously increased as it passes through the vocal cords. The airflow is ejected forcefully, increasing the permeability and diffusion rate of carbon dioxide. Studies have shown that the higher the human

voice's loudness, the higher the increased aerosol emission rate. [4] Some papers pointed out that the exponential flow has the highest peak inhalation flow (PIF)] and a higher penetration value. [5] Therefore, the rapid and short shouting method can accelerate carbon dioxide diffusion and increase permeability. Moreover, this pattern of chanting slogans is similar to the collective running of the army. The sound's resonance effect can slightly relieve the fatigue of muscles and other trachea and relieve psychological pain. Rhythmic shouting can make breathing more rhythmic and increase breathing efficiency. [6] [7]

3. PRINCIPLES OF BLOOD OXYGEN SATURATION AND PULSE OXIMETRY

Blood oxygen level is a measure of how much oxygen the red blood cells carry. Blood oxygen saturation is an indicator of this measurement. It measures the amount of oxygen attached to hemoglobin cells in the blood circulatory system. This measurement indicates the efficiency of breathing and the efficiency of blood flow throughout the body. The oxygen saturation is used as a percentage to illustrate the result of this measurement. Following is the calculation formula.

$$SpO_2 = \frac{HbO_2}{HbO_2 + Hb} \quad (1)$$

where is oxygenated hemoglobin (oxyhemoglobin) and Hb is deoxygenated hemoglobin. The arterial blood oxygen saturation of an average human body is 95% to 99%. Less than 95% is defined as a state of insufficient oxygen supply.[8]

Blood Oxygen Saturation (SpO2) is the result of pulse oximeter measurement. Unlike traditional blood gas analysis methods for checking blood, pulse oximeter measurement uses a non-invasive method to measure blood oxygen saturation. It can quickly measure blood oxygen levels. The detection method uses the principle of the change in light absorption during arterial pulsation. The amount of light absorbed by blood oxygen is related to the oxygen content in the blood. The oxidized hemoglobin absorbs more infrared light and allows more red light to pass through. Deoxyhemoglobin is the opposite. In other words, at high oxygen saturation, infrared light absorption is more than red light absorption. At low oxygen saturation, infrared light absorption is less than red light absorption. The detection uses visible red light (660 nanometers) and infrared spectrum (940 nanometers), two LED light sources to illuminate the tested area alternately. On the opposite side of the LED is a light detector, which is used to measure relative light absorption multiple times per second and average the detection results once every three seconds. Finally, measure their respective transmittance and calculate the ratio. Then map the ratio value to the blood oxygen saturation curve. The blood oxygen saturation needs to be obtained by comparing the ratio with the relevant numerical table. In figure 2, It is a ratio calibration curve of red light and infrared light transmittance [9]. It is easy to find the blood oxygen saturation values corresponding to different ratios from the figure. [10] [11]

The calculation of the ratio is the result of the ratio of red-light transmittance A_r and infrared light transmittance A_{Ir}.

$$R = \frac{A_r}{A_{Ir}} \quad (2)$$

For the calculation of light transmittance, Beer-Lambert law can be used.

$$A = \ln \frac{I_o}{I} \quad (3)$$

Here A is the absorbance. I is the intensity of transmitted light. I_o is the original intensity of light. When the original light intensity is fixed, the light monitor monitors the light transmission intensity to calculate the light transmittance of various lights. [12] [13]

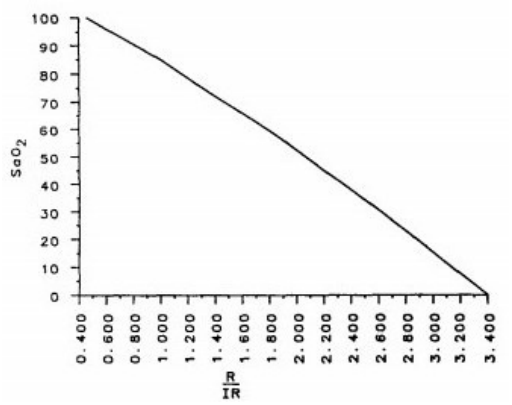

Figure 2. The relationship between red/infrared ratio and oxygen saturation, as a typical calibration curve of pulse oximeter.[9]

4. EXPERIMENTS AND RESULTS

The subjects of the experiment were six college students in their 20s. There are three men and three men each, and none of them has a history of respiratory diseases. Experimental equipment includes a KF94 mask and pulse oximeter. The speeds set at three different levels, which are 3km/h, 6km/h, and 10km/h. The subjects measured the blood oxygen saturation of normal breathing and shouting breathing patterns when wearing a mask at different speeds. The experimental measurement started after 5 minutes of jogging wearing a mask. The duration of each experiment is 3 minutes, and the interval between experiments is 10 minutes. [14]

Fig.3 and Fig.4 respectively record a subject's blood oxygen saturation curve at a running speed of 6km/h, normal breathing pattern, and shouting breathing pattern. The normal breathing pattern's blood oxygen saturation is significantly reduced, with an average of 95%. Furthermore, there are great ups and downs. The ups and downs of the curve reflect the regulation of normal breathing. Normal breathing will automatically adjust the breathing rate and breathing depth according to the body's changes in oxygen content to maintain oxy-gen balance. However, this breathing pattern is variable, and there is no rhythm, so the blood oxygen saturation will increase and sometimes decrease. However, the blood oxygen saturation of the shouting breathing pattern is relatively stable, with little fluctuations. It is maintained at around 97%. This is the result of controlling breathing. Because the shouting breathing pattern can increase oxygen in-take and accelerate the diffusion of carbon dioxide, improve breathing efficiency, and keep blood oxygen stable. However, the blood oxygen saturation decreased significantly after two minutes. Because it is challenging to keep shouting to breathe for a long time. It not only improves breathing efficiency but also consumes more oxygen. The Long-term will cause the blood oxygen saturation to drop. Therefore, it is better to combine the normal breathing pattern and the shouting breathing pattern.

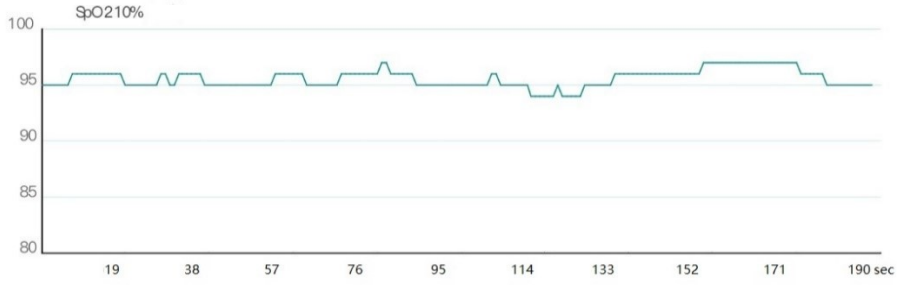

Figure 3. While jogging in 6km/h with a mask, the blood oxygen saturation curve of a subject's normal breathing pattern.

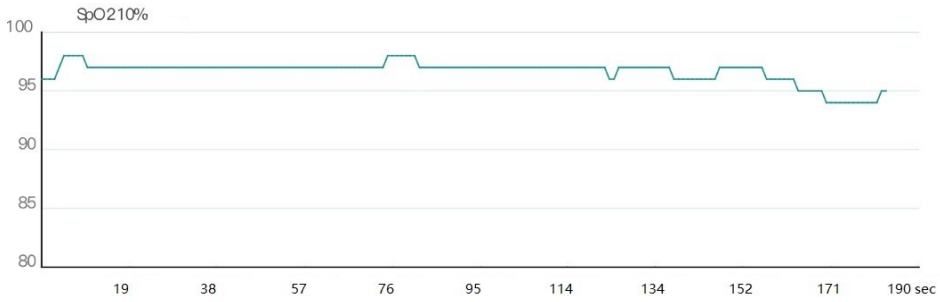

Figure 4. While jogging in 6km/h with a mask, the blood oxygen saturation curve of a subject's shouting breathing pattern.

Average the six testers' data to obtain the statistical histogram of the average blood oxygen saturation values of the normal breathing pattern and the shouting breathing pattern at the three speeds while wearing the mask, as shown in figure 5. It can be seen from the figure that, regardless of the speed of wearing a mask, the blood oxygen saturation to maintain a normal breathing pattern is reduced. When the speed is 10km/h, the average value of blood oxygen saturation is lower than 95%. For the shouting breathing pattern, the improvement effect is obvious at low speed (3km/h) and medium speed (6km/h). The blood oxygen saturation increased by +1.5% at low speed, and the blood oxygen saturation increased by +0.8% at medium speed. However, for higher speed (10km/h), there is no obvious improvement effect. Because as the speed increases, oxygen consumption increases sharply, and the maximum value of breathing oxygen is lower than oxygen consumption, so blood oxygen saturation drops significantly below 95%. Because of the obstructive effect of masks, it has always existed. The change of breathing pattern cannot have a good improvement effect. The effect of improving the blood oxygen saturation of shouting breathing decreases as the speed increases.

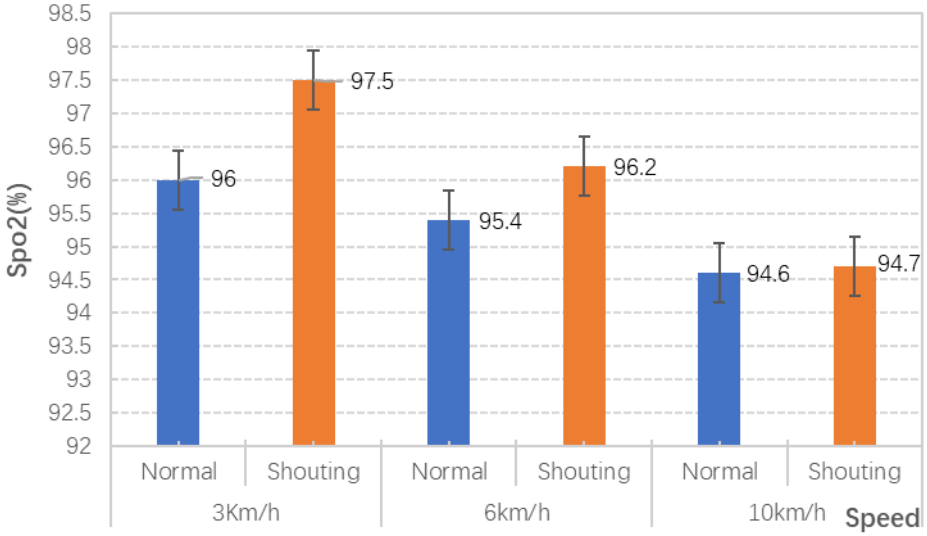

Figure 5. Histogram of average blood oxygen saturation of normal breathing pattern and Shouting breathing pattern at different running speeds when wearing a mask.

5. CONCLUSION

Because of the COVID-19 pandemic, people have to wear masks to walk and jog in the park. They pursue the health of physical functions but ignore the health of breathing. To reduce the impact of wearing masks on people's health, a breathing pattern that improves blood oxygen saturation during low-speed running is

proposed to ensure the body's oxygen balance. This paper measured the blood oxygen saturation at different running speeds when wearing a mask.

The experiment results show that the shouting breathing pattern significantly improves blood oxygen saturation of low-speed and medium-speed running. They increased by +1.5% and +0.8%. However, it has little effect on the high-speed running state. The blood oxygen saturation curve in figure 3 shows that the combination of deep breathing and shouting breathing is better for medium-speed running. It is recommended that each time the shouting breathing pattern is continuously performed for 1 minute, and the deep breathing pattern is two minutes. The oxygen inhalation pattern is the same as the shouting breathing pattern, but do not need to shout when exhale. Finally, because high-speed running consumes much oxygen, the blood oxygen saturation is lower than 95%. Therefore, it is not recommended to run at high speed and participate in high oxygen consumption while wearing a mask. The blood oxygen improvement effect of the shouting breathing pattern is limited to walking and low-speed jogging.

REFERENCES

[1] Zhixing Tian, Young-Eun Yi, Myung-Jin Bae "A study on vocal breathing to improve activity blood oxygen saturation when wearing a mask," SSRG International Journal of Engineering Trends and Technology, Vol-ume 69, Issue 2, pp. 107-111, February 2021.

[2] Zhixing Tian, Myung-Jin Bae, "'Bu' vocal breathing method to improve blood oxygen saturation when wearing a mask," SSRG International Journal of Engineering Trends and Technology, Volume 68, Issue 10, pp. 33-36, October 2020.

[3] Zhixing Tian, Bong-Young Kim and Myung-Jin Bae, "A study on healthy breathing pattern when wearing a mask," International Journal of Engineering Research and Technology, Volume 13, Issue 7, pp. 1562-1566, 2020,

[4] Asadi, S., Wexler, A.S., Cappa, C.D. et al. Aerosol emission and superemission during human speech in-crease with voice loudness. Sci Rep 9, 2348, 2019.

[5] Wang A Richardson AW Hofacre KC. "The effect of flow pattern on collection efficiency of respirator filters," J Int Soc Respir Prot; 29: 41–54, 2012

[6] Bong-Young Kim, Myung-Jin Bae, "A study on the stress reduction effect of reading aloud the book using HRV," International Journal of Engineering Research and Technology, Volume 12, Issue 9, pp. 1457-1461, 2019.

[7] Bong-Young Kim, Ahn Ik-soo, Myung-Jin Bae "A study on lung function activation of sound necklace," Journal of Engineering and Applied Sciences, Volume 13, Issue 3, pp. 650-654, 2018.

[8] Wikipedia, Oxygen saturation, Submission of manuscript. *https://en.wikipedia.org/wiki/Oxygen_saturation_(medicine)#cite_note-9.*

[9] James E Sinex, Pulse oximetry: Principles and limitations, "The American Journal of Emergency Medicine," Volume 17, Issue 1, Pages 59-66, 1999.

[10] Bao-guo Yao, Yu-xiao Wang, Xiang-yu Ye, Fei Zhang, Yun-liang Peng, "Impact of structural features on dynamic breathing resistance of healthcare face mask," Science of The Total Environment, Volume 689. pp. 743-753, 2019.

[11] Oximetry.org, Pulse Oximeter, Submission of manuscript *https://web.achive.org/web/20150318054934/http://www.oximetry.org/pulseox/principles.htm.*

[12] Wikipedia, Adrian Curtin, Pulse oximetry, Submission of manuscript. *https://en.wikipedia.org/wiki/Pulse_oximetry#Indication.*

[13] Anaesthesia UK, Principles of pulse oximetry. *https://web.archive.org/web/20150224221820/http://www.frca.co.uk/article.aspx?articleid=332.*

[14] Zhixing Tian, Bae Seonggeon, Myung-Jin Bae, "On the effect of everyday stress by repeated vocalization of "voo"," SSRG International Journal of Engineering Trends and Technology, Volume 68, Issue 9, pp. 162-166, November 2020.