

## **A Study on the Effect of Jogging on Stress Reduction**

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### **ABSTRACT**

The root of stress is the Latin "Stringer" which means "tighten tight". Modern people are under a lot of stress. Stress is the source of all disease, and if not overcome, it can develop into a physical or mental illness. On the other hand, when overcoming stress and responding well, stress becomes a positive stimulus, which is the basis for achieving a healthy and happy life. Jogging is a very good way to reduce stress for busy modern people. Jogging and other mild exercises help improve mental health by facilitating oxygen supply to the brain and eliminating waste products from the body. In this paper, we investigated the influence of stress reduction on Heart Rate Variability (HRV) measurements on jogging, which is known to be helpful for stress reduction. The stress index (SDNN) changes measured before and after jogging in 15 adult men showed that the stress index improved after jogging in 13 of 87%. These results confirm that the stress is actually reduced as the jogging improves the stress index.

**Keywords:** Stress, Modern People, Jogging, Heart Rate Variability (HRV), Stress Index (SDNN)

### **I. INTRODUCTION**

Stress is the origin of the Latin word "Stringer", which means "tighten tight" in 19th century physics. In the medical field, it is defined as "resistance to maintaining a stable state against stimulation to break the mental / physical balance and stability". Stress is the source of all illness and causes mental and physical illnesses. 70% of the major causes of death - cancer, cerebrovascular disease and cardiovascular disease - are caused by stress. Especially modern people are getting more stressed due to the more complicated social structure and intensifying competition. One of the most frequently

used foreign words in Korea is reported as stress, which shows how many people are exposed to stress. Stress can be divided into positive stress (eustress) and negative stress (distress). Even if stress is burdensome right now, if you respond well to stress, it will become a stimulant to improve your productivity, enhance your creativity, and give vitality to your life to achieve a healthy and happy life. In this way, positive stress (eustress) can be said to be a positive result when overcome and control stress. However, persistent stress despite coping or adapting to stress can cause symptoms such as anxiety and depression, and can develop into a physical or mental illness. This can be called negative stress. In the end, it is very important how well you can cope and control stress [1,2,3].

Removing stressors is the most important way to overcome stress. However, stressors are inevitable for modern peoples living in modern society. Apart from the elimination of stressors, healthy eating, adequate sleep, regular exercise, listening to music, deep breathing, and meditation help to overcome stress. Many people are encouraged to exercise lightly, including jogging, to reduce stress. Jogging is a typical aerobic exercise, which means running slowly and comfortably. It is known that exercise lightly, including jogging, is very helpful for improving mental health. Especially for modern peoples with very little movement, jogging can be a very important way to reduce stress. For modern peoples, jogging is an essential activity that effectively improves the basic physical strength, improves mental health effectively by discharging waste products, and can be carried out without regard to time and place [3,4,5,6].

In this paper, we measured the change of the stress index using Heart Rate Variability to see how effective jogging, which is known to be effective for stress reduction, actually contributes to stress reduction. Chapter 2 explains jogging, which is known to help with stress reduction, Chapter 3 explains Heart Rate Variability and stress index. Chapter 4 presents the results of experiments and conclusions in Chapter 5.

## **II. JOGGING**

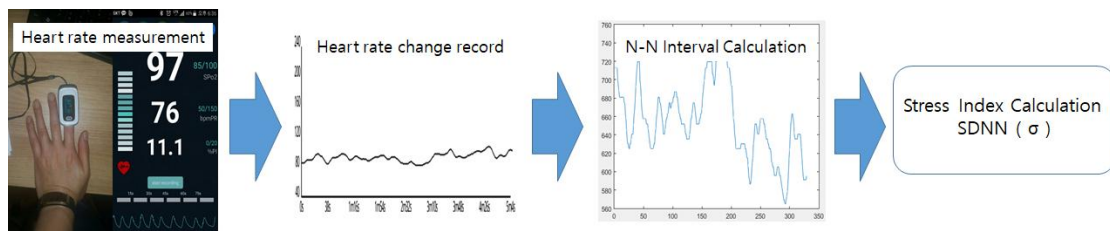
Jogging is a type of "Jog" that means "run slowly" and means running slowly for health maintenance or exercise. The jogging method can be done by lightly riding the house or walkway, etc. It is also recommended to run at a speed of around 8 km/h. Jogging is known to have a great variety of beneficial effects, such as increased intestinal health and memory, induction of endorphin secretion, improved brain health and mental health, even in a short period of time. In particular, light exercise such as jogging increases the blood flow rate to the brain tissue, thereby increasing the oxygen supply to the brain and discharging the saline and waste products from the sweat, which is a very good way to reduce stress [7,8,9].

## **III. HEART RATE VARIABILITY AND STRESS INDEX**

**Heart Rate Variability (HRV):** Heart is a very strong and important organ that works for a lifetime. This heart plays a contraction movement of two atrium, two ventricles and serves as a pump to supply blood to all parts of the body. The movement of heart

repeats the PQNST process, which is a total of five steps. The number of occurrences of the N process for one minute, which corresponds to the first ventricle, is called the heart rate (HR). Heart Rate Variability (HRV) is the degree to which the N-N interval, the period of heartbeat, changes with time, and is the information indicating the activity and balance of the autonomic nervous system. HR Tachograph, HR Distribution, HR Histogram, and SDNN (Standard Deviation N-N Interval) can be obtained from Heart Rate Variability, and SDNN is used as a stress index [10].

**Stress Index (SDNN):** When a person is stressed, the ability to control the autonomic nervous system falls. The autonomic nervous system regulates the movement of various organs according to the internal and external environmental effects of the body to maintain the homeostasis of the body. Therefore, a healthy and less stressed person experiences rapid response of autonomic nervous system to oxygen concentration, blood pressure, body temperature, external temperature, etc., and heart rate variability is large. Conversely, people who are unhealthy or stressed have a low Heart Rate Variability. In 1996, "Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology" presented a guide to Heart Rate Variability (HRV) analysis methods and standards. To date, most heartbeat-related medical devices follow this standard. SDNN (Standard Deviation N-N Interval) is used as a stress index among the indicators that can be confirmed through Heart Rate Variability (HRV). SDNN is a standard deviation of N-N interval. Low SDNN means more stress, and higher SDNN means lower stress. In this paper, heart rate changes were recorded by using Pulse Oximeter and APP of smartphone, and SDNN was calculated by this. The process of calculating the SDNN, the stress index, from the heart rate measured using the pulse oximeter is shown in Figure 1 [10].



**Fig 1.** The process of calculating SDNN from heart rate measurement

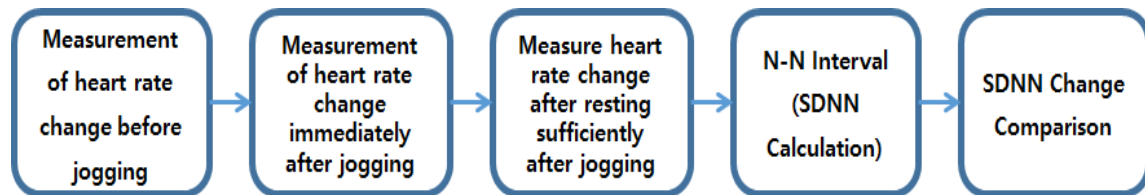
In this case, the method of calculating SDNN from N-N Interval is shown in Equation (1).

$$SDNN (\sigma) = \sqrt{\frac{\sum_{k=1}^N (x_k - \mu)^2}{N}} \tag{1}$$

where  $x_k$  is k's N-N Interval, and  $\mu$  is N-N Interval's Mean

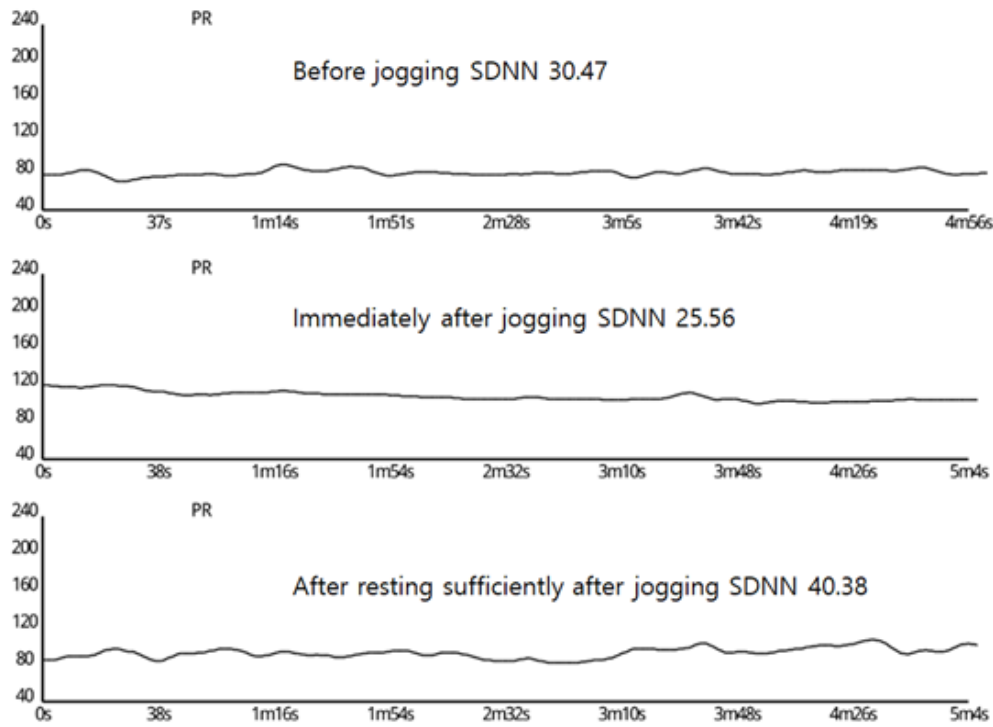
#### IV. EXPERIMENTS AND RESULTS

To examine the effect of jogging on stress reduction, 15 healthy male subjects aged 20 ~ 60 years were subjected to an experiment to measure stress before and after jogging. In the experiment, 15 adult male subjects measured changes in heart rate for 5 minutes before jogging, and immediately after jogging for 15 minutes at home or near work, heart rate changes were measured for 5 minutes each. After a sufficient rest of about 50 minutes, if the heart rate was stabilized to the pre-jogging level, the heart rate was further measured every 5 minutes. Based on the collected 45 heart rate change data, SDNN was calculated to confirm the correlation between jogging and stress index. In order to minimize the experimental error in measuring the heart rate change, the participants measured changes in the heart rate without talking and without moving. Figure 2 shows the experimental results of heart rate change measurement and SDNN calculation.



**Fig 2.** Heart rate change measurement and SDNN comparison procedure

Figure 3 is a graph showing how the heart rates of subjects M-1 before jogging, Immediately after jogging, and After resting after after jogging change for 5 minutes, respectively. Figure 3 shows that the heart rate before jogging changes little by little about 60 times per minute, and Immediately after jogging shows that the heart rate is gradually decreasing from about 120 to 80 times per minute. After resting sufficiently after jogging, we can see that the heart rate is changing very actively around 80 times per minute. Based on the results of the change in heart rate, SDNN, the stress index, was calculated to be 30.47 before jogging and dropped to 25.56 Immediately after jogging. In addition, after resting sufficiently after jogging, the SDNN increased sharply to 40.38, indicating that the stress was improved in after resting sufficiently after jogging compared with before jogging.



**Fig 3.** Comparison of changes in heart rate between before/after Jogging

Table 1 shows the experimental results of 15 men in their 20s and 60s participating in the experiment. The N-N interval was calculated from the heart rate change data measured before jogging, Immediately after jogging, and After resting after after jogging, respectively. From this, we calculated the SDNN, the stress index, and compared the calculated SDNN.

**Table (1)** SDNN calculation result

Subject	Before jogging (①)	Immediately after jogging (②)	After resting sufficiently after jogging (③)	SDNN increase / decrease after jogging (③ - ①)
M-1	11.05	22.44	18.01	6.96
M-2	29.52	21.39	38.02	8.5
M-3	28.41	19.89	37.79	9.38
M-4	24.13	13.5	27.77	3.64
M-5	19.94	34.63	40.39	20.45

Subject	Before jogging (①)	Immediately after jogging (②)	After resting sufficiently after jogging (③)	SDNN increase / decrease after jogging (③ - ①)
M-6	30.47	25.56	40.38	9.91
M-7	40.37	10.32	32.17	-8.2
M-8	24.04	55.6	61.25	37.21
M-9	13.99	12.49	25.86	11.87
M-10	38.78	31.45	48.66	9.88
M-11	49.01	26.08	80.11	31.1
M-12	31.19	25.56	28.4	-2.79
M-13	15.1	24.46	55.7	40.6
M-14	27.18	21.23	40.6	13.42
M-15	42.29	27.01	50.99	8.70

As shown in Table 1, the SDNN values of the four participants increased when they were immediately after jogging compared to before jogging. The remaining 11 patients had a decrease in SDNN levels. Also, 14 participants were elevated when they were after resting sufficiently after jogging compared to Immediately after jogging. One patient had a decrease in SDNN. Immediately after jogging, the heart rate was very fast, and during the measurement period, some participants had a rapid decline in the accelerated heart rate. Because of this phenomenon, it was difficult to identify patterns of SDNN change in most participants during Immediately after jogging. However, it is noteworthy that we found that when the heart rate was stabilized at rest, the SDNN values were mostly increased and the stress was improved, compared to when jogging was not performed. Figure 4 is a graph showing how the SDNN value changes after jogging compared to before jogging based on the result of SDNN calculation in Table 1. Figure 4 excludes the SDNN value of Immediately after jogging.

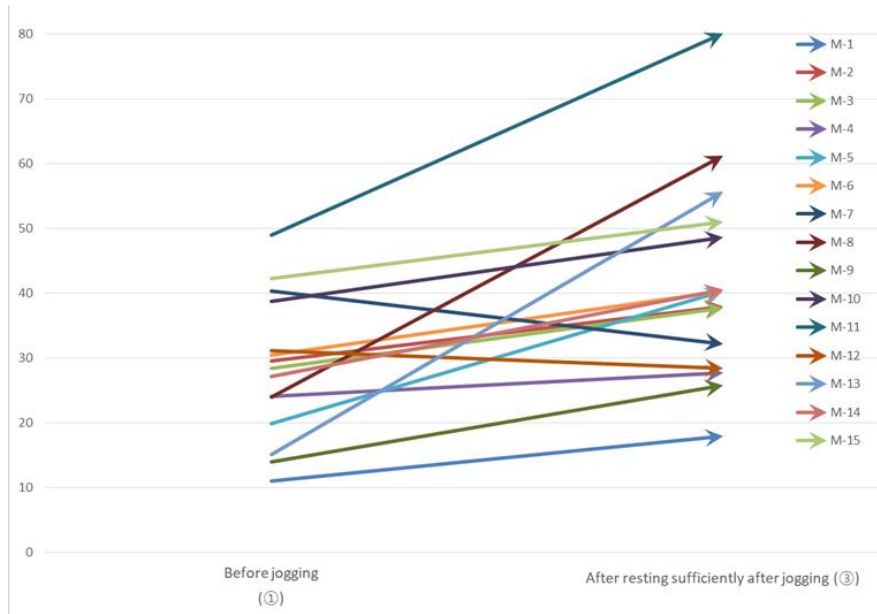


Fig 4. Heart rate change measurement and SDNN comparison procedure.

V. CONCLUSION

Stress is an inevitable phenomenon that can not be avoided in living modern life. On the other hand, even if the stress is somewhat burdensome, it is a positive stress (eustress) that gives life vitality and healthier and happier life by response well and overcoming. Therefore, how well you cope with stress can be a very important task for modern peoples. There are many ways to overcome stress, but among them jogging is a very good way for busy modern peoples to improve their basic stamina and overcome stress.

We tried to confirm the effect of the actual reduction of stress on jogging, which is known to be a very effective way to reduce stress, through measurement of Heart Rate Variability. As a result of the experiment in Chapter 4, in a total of 15 healthy male subjects, 87% of the subjects, 13 of them showed improvement of stress after jogging and 2 of them showed no improvement of stress due to decrease of stress index. Respectively. Immediately after jogging, the stress index was lowered by 11 out of 15, but this is a momentary phenomenon caused by a very rapid heart rate for rapid oxygen delivery to all parts of the body. After resting for a while after the exercise, when the heart rate was stabilized, the stress index was increased and the stress was improved before jogging. This is the result of experimentally confirming that light exercise, including jogging, is helpful for stress reduction.

Most modern peoples are stressed more and more in a fiercely competitive society, rather than overcome the stresses given. For these modern peoples, jogging is a great way to overcome stress, anytime, anywhere. Many people expect to be able to live healthy and energetic lives without stress through light exercise such as jogging.

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