

Correlation between Objective and Subjective Evaluations using Salivary Amylase and PMOS when wearing Oxygen Devices

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Abstract: - This paper describes the quantitative measurement of stress when wearing an oxygen device. Stress was quantified in two ways. One is objective stress and the other is subjective stress. Furthermore, the relationship between these two stresses was evaluated. As a result, objective stress was significantly increased by wearing an oxygen device. Also, subjective stress was significantly increased in two of five items expressing negative emotions. Regarding the relationship between objective stress and subjective stress, we showed that SAA, which is an index of objective stress, and FI, which represents fatigue of subjective stress, correlated with a correlation coefficient of 0.51. Wearing an oxygen mask increased SAA levels in saliva, suggesting that mask wearers may be feeling stressed. Furthermore, it was shown that the objective stress indicated by salivary amylase may indicate the degree of fatigue. It is thought that a higher degree of stress can be evaluated by combining the objective stress evaluation method and the subjective stress evaluation method.

Key Words: - Objective evaluation, Subjective evaluation, Salivary amylase, PMOS, Oxygen device, Negative emotions, SAA, stress.

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1 Introduction

There are various types of devices used for oxygen therapy (hereinafter referred to as oxygen devices), such as cannulas and masks. Due to the difference in contact location/area and gas spray structure, discomfort due to skin irritation may occur. For this reason, healthcare professionals should select therapeutic oxygen devices by considering the reduction in discomfort of patients. However, they have not quantitatively measured the stress experienced when wearing each oxygen device, and only rely on individual evaluations of the shape and other factors. Attention is increasing to pressure injuries to patient skin caused by medical devices. Humid conditions pose a special risk of skin injury due to the increased friction coefficient, [1].

Therefore, we used salivary amylase which is known to be able to objectively quantify stress, to evaluate the stress that occurs when various oxygen devices are attached to NPPV, [2]. This time, we newly introduced the POMS(Profile of Mood States)test, which is often used as an index of subjective stress. We evaluated the relationship between objective stress and subjective stress caused by wearing an oxygen device.

2 Target and Method

2.1 Salivary Amylase Activity Value

Common stress assessment methods include objective stress assessment methods and subjective

stress assessment methods. The objective stress assessment method used in this study uses non-invasive salivary amylase activity value (hereinafter referred to as SAA), heart rate, hair/nail cortisol, and invasive blood stress-related substances (adrenaline, plasma cortisol) as stress markers, [3], [4], [5], [6]. For objective stress evaluation, we used this SAA.

The equipment used was a dry clinical chemistry analyzer saliva amylase monitor manufactured by NIPRO (medical device notification number 27B1X00045000110) and a dedicated saliva collection chip. SAA [kIU/L] can be measured by inserting a special chip under the tongue, collecting saliva, placing the chip in a holder, and setting it in the main body of the equipment. Since SAA is affected by the amount of amylase, participants were asked to rinse their mouths with a glass of water before measuring amylase.

2.2 POMS Test

The POMS(Profile of Mood States)test, which is a questionnaire method for evaluating mood, was used to evaluate subjective stress. This POMS test can assess temporary mood/emotional states. The evaluation items are AH (Anger-Hostility), CB (Confusion-Bewilderment), DD (Depression-Dejection), FI (Fatigue-Inertia), TA (Tension-Anxiety), VA (Vigor-Activity), and F (Friendship). AH (Anger-Hostility), CB (Confusion-Bewilderment), DD (Depression-Dejection), FI (Fatigue-Inertia), and TA (Tension-Anxiety) indicate negative mood states. VA (Vigor -Activity) and F (friendliness) indicate a positive mood state. The scores obtained from the seven mood state scales were converted into standardized scores (T values) that took gender and age into consideration, [7]. Additionally, TMD (total mood disorder) was assessed. TMD can be expressed by adding five negative mood states and subtracting VA (Vigor -Activity), [7]. The formula representing TMD is shown in (1).

$$TMD = (AH + CB + DD + FI + TA) - VA \quad (1)$$

3 Target

The oxygen device used was the Ecolite Mask manufactured by Japan Medical Next Co., Ltd., shown in Figure 1. The participants were 20 healthy male volunteers (average age 21 years; standard deviation ± 1 year) who were recruited in advance as student volunteers. The study was submitted to the university where the author worked and consent was obtained. Verified for the period from October

1, 2021 to October 31, 2021. As an ethical consideration, we fully explained the purpose and significance of this study to the subjects who requested their cooperation, and we began the study after obtaining their written consent.



Fig. 1: Ecolite Mask

4 Method

There are two groups. One is “not wearing an oxygen mask,” and the other is “wearing an Ecolite mask.” They lay on a bed in a relaxed position for an hour with or without an Ecolite mask. To check the reaction when wearing the Ecolite mask for 1 hour, we conducted SAA measurements and POMS tests before and after lying down. Wilcoxon signed rank sum test was used for statistical analysis, and the level of statistical significance was set at a hazard rate of less than 5%. The relationship between objective stress and subjective stress was evaluated using Spearman's rank correlation coefficient test for the values of items that showed significant differences between the POMS test and the SAA value.

5 Results

5.1 Salivary Amylase Activity Value (SAA)

Figure 2 shows the change in SAA values before and after wearing a mask. The 1-hour median change without a mask was 0 (IQR[-1-0.25]) and the 1-hour median change with mask was 0 (IQR[0-2]). Figure 2 shows the values of each amount of change expressed in quartiles. Although there was some variation, SAA was significantly higher when wearing a mask than when not wearing a mask. The result of the Wilcoxon signed rank sum test was a statistic of 20. Because this data is a small sample, we also followed a signature rank table. The probability that the statistical value will be 21 or

less is 0.0471, indicating that SAA significantly increased by wearing an oxygen mask.

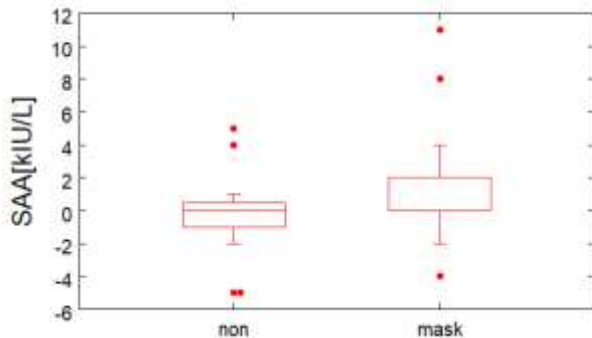


Fig. 2: Comparison of changes in salivary amylase activity when wearing a mask and not wearing a mask

5.2 POMS Test

Table A.1 (Appendix) lists the T values before and after wearing the mask for each of the seven mood categories determined by the POMS test. The amount of change between before and after wearing is FI (Fatigue - Inertia), AH (Anger - Hostility), DD (Depression-Dejection), TA (Tension - Anxiety), VA (Vigor - Activity), CB (Confusion-Bewilderment), followed by F (Friendship). VA (Vigor - Activity), CB (Confusion-Bewilderment), and F (friendliness) showed a decrease in T value after wearing the mask, but VA (Vigor - Activity) and F (friendliness) showed a positive mood state. This indicates a change in negative emotions.

Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9 show the T values for each evaluation item before and after wearing a mask, expressed in quartiles.

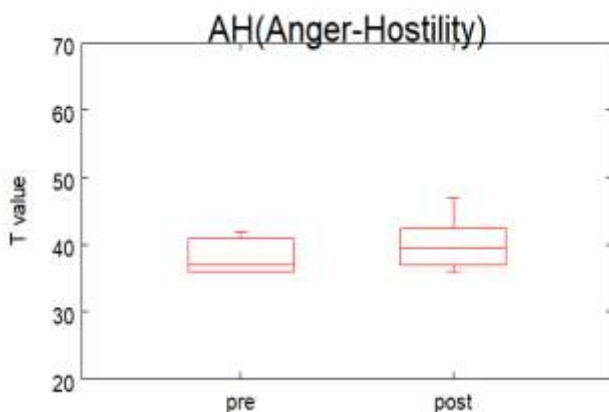


Fig. 3: POMS test: AH (Anger-Hostility) changes before and after wearing a mask

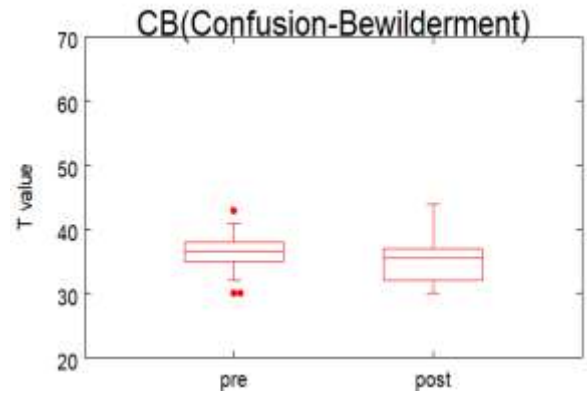


Fig. 4: POMS test: CB (Confusion-Bewilderment) changes before and after wearing a mask

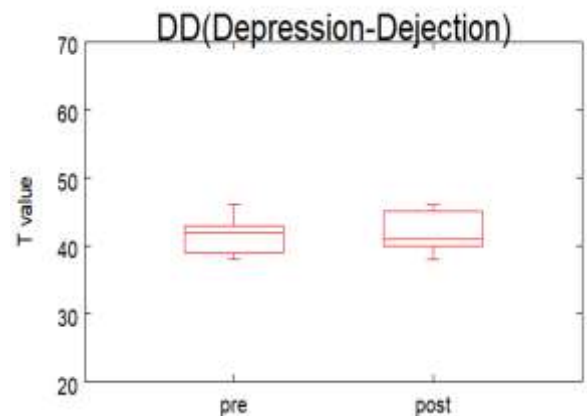


Fig. 5: POMS test: DD (Depression-Dejection) changes before and after wearing a mask

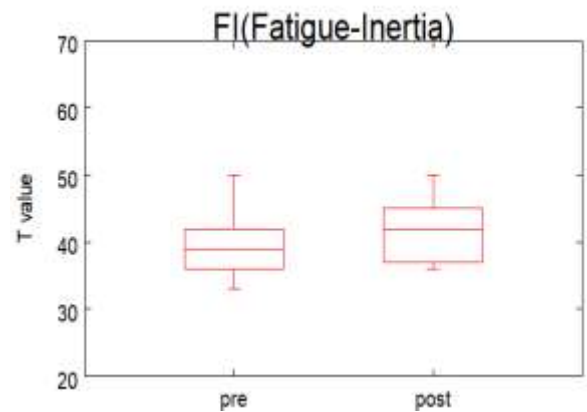


Fig. 6: POMS test: FI (Fatigue-Inertia) changes before and after wearing a mask

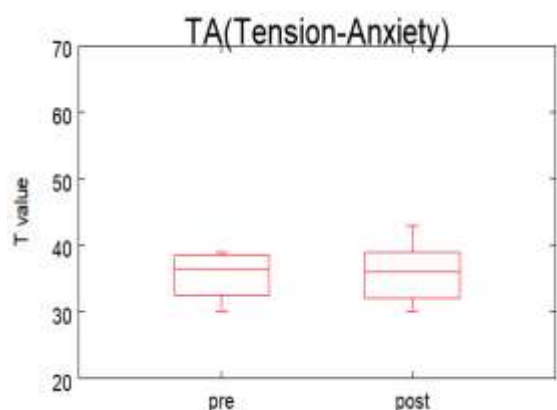


Fig. 7: POMS test: TA (Tension-Anxiety) changes before and after wearing a mask

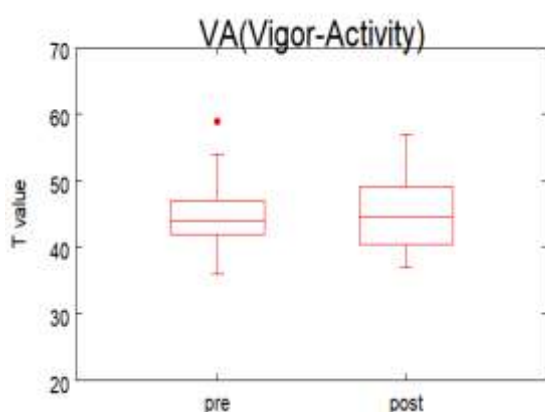


Fig. 8: POMS test: VA (Vigor-Activity) changes before and after wearing a mask

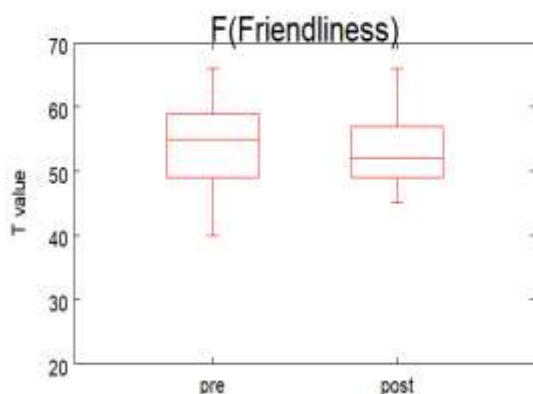


Fig. 9: POMS test: F (Vigor-Friendliness) changes before and after wearing a mask

Figure 10 shows TMD (total mood disorder) which can be expressed by adding five negative mood states and subtracting VA (Vigor -Activity).

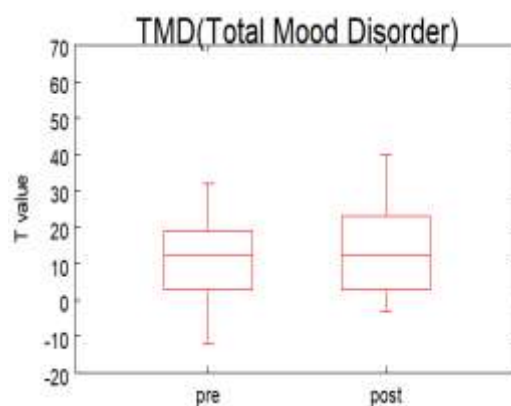


Fig. 10: TMD (total mood disorder)

The results of the Wilcoxon signed rank sum test are AH (Anger-Hostility) $p < 0.0473$, CB (Confusion-Bewilderment) $p > 0.05$, DD (Depression-Dejection) $p > 0.05$, FI (Fatigue- Inertia) $p < 0.0467$, TA (Tension-Anxiety) $p > 0.05$, VA (Vigor - Activity) > 0.05 , F (Friendship) $p > 0.05$, TMD (Total Mood Disorder) $p > 0.05$. The p-value could not be determined because the data sample was small. The values of AH (Anger-Hostility) and FI (Anger-Hostility) increased significantly in each group, and there were no significant differences in the other five items and TMD (Total Mood Disorder).

5.3 Comparison of Salivary Amylase Activity Value and POMS Test

The correlation coefficients for the 7 items of the SAA test and POMS test are TA (Tension-Anxiety), FI (Fatigue-Inertia), AH (Anger-Hostility), CB (Confusion-Bewilderment), DD (Depression-Dejection), and VA. (The ranking is highest for Activity (Activity), followed by F (Friendship)). The results of Spearman's rank correlation coefficient test are TA (Tension-Anxiety) 0.592, FI (Fatigue-Inertia) 0.545, AH (Anger-Hostility) 0.378, CB (Confusion-Bewilderment) 0.313, DD (Depression-Dejection) 0.157, VA (Vigor - Activity) -0.344, F (Friendship) -0.378, TMD (Total Mood Disorder) 0.641. Correlations found in each group were as follows: TA (Tension -Anxiety) 0.592, FI (Fatigue-Inertia) 0.545, and TMD (Total mood disorder) 0.641, all of which were positive.

6 Consideration

Wearing the Ecolite mask significantly increased SAA levels in saliva, and POMS testing also showed a change in mood before and after wearing the mask, suggesting that mask-wearing may be a cause of stress. Although SAA values are an

objective and quantitative method of measuring stress, and the correlation between SAA values and stress has been widely reported, [8], [9], [10], the physical effects of masks on salivary glands are debated. We have already reported that direct physical effects on salivary glands due to mask contact are unlikely to affect SAA values, and this study found that the increase in SAA values after wearing an Ecolite mask was due to the stress caused by wearing the mask. It turned out to be due to stimulation. It turned out to be the cause. This is thought to be due to a biological reaction.

In addition, we previously measured the amount of change in the SAA value before and after wearing an oronasal NPPV mask that was subjected to pressure load under the same conditions as in this study; Oronasal NPPV masks subjected to pressure loading under the same conditions as in this study, [2]. Skin irritation to the face is thought to be a factor in the increase in SAA values due to wearing a mask, but it was also found that SAA values also increase due to pressure load.

Oxygen therapy is often used for a long time, and it has been reported that the mask straps can cause skin problems on the auricles. A typical mask has straps that are worn over the ears, [11]. On the other hand, the Ecolite mask has a structure that reduces ear discomfort by attaching the strap under the ear. Furthermore, the part that comes into contact with the face is made of a polymeric elastomer with rubber elasticity, making it soft. However, even with the use of a high-performance oxygen mask, the SAA value increased, and the discomfort caused by skin irritation caused by oxygen devices cannot be eliminated. It is thought that it is necessary to take measures at intervals, such as removing the mask periodically to reduce stress.

In the POMS test, only FI (Fatigue-Inertia) and AH (Anger-Hostility) had significantly higher T values when wearing an oxygen mask. AH (Anger-Hostility) is a value that increases when you are in a bad mood or irritated, and it is thought that these emotions are induced by the burden of wearing a mask. In particular, there are two items that express stress: FI (Fatigue-Inertia) and AH (Anger-Hostility), and a significant difference was observed between these two items, suggesting that wearing a mask may be a stress factor. Furthermore, Table A.1 (Appendix) shows that among the seven items, only CB (Confusion-Bewilderment) showed no negative change in the mean value before and after the experiment. CB (Confusion-Bewilderment) changes negatively when you are in a situation that prevents you from achieving your goals, such as when you want to concentrate but can't, or when you can't

organize your thoughts, [12]. It is thought that there was no change in this experiment because no work was required. Since stress is a complex combination of multiple factors, it is thought that combining SAA and POMS2 has made it possible to evaluate stress at a higher level.

A comparison of the SAA and POMS tests showed a correlation between TA (Tension anxiety), FI (Fatigue-Inertia), and TMD (total mood disorder). This may be due to abnormal Anxiety from wearing an oxygen mask and Fatigue from lying on my back in bed for an hour. On the other hand, AH (Anger-Hostility) significantly increased with oxygen mask use, but there was no correlation with changes in SAA. This suggests that AH (Anger-Hostility) may not be included in the stress that can be measured by SAA. On the other hand, TMD (total mood disorder) showed the strongest correlation. A limitation of this study is that it only evaluated one type of mask, so multiple masks may need to be evaluated. The subjects were limited to healthy people in their 20s. If the stress of the underlying disease is large, the stress of the mask may be canceled out, and in the future, it will be necessary to evaluate this in hospitalized patients who require oxygen therapy.

7 Conclusion

Wearing an oxygen mask increased SAA levels in saliva, suggesting that the mask wearer may be feeling stressed. It is thought that a more sophisticated stress evaluation can be achieved by combining objective stress evaluation methods and subjective stress evaluation methods.

The main results are as follows.

(1) SAA significantly increased when spending 1 hour with and without an oxygen mask.

(2) When wearing an oxygen mask, AH (Anger-Hostility) and FI (Fatigue-Inertia) significantly increased, $p=0.0219$ and $p=0.0147$, respectively.

(3) As a result of comparing the SAA and POMS tests, the correlation coefficient with SAA was positively correlated with TA (Tension-Anxiety) 0.592, FI (Fatigue-Inertia) 0.545, and TMD (total mood disorder) 0.641.

(4) Since this study evaluated only one type of mask, it will be necessary to evaluate multiple masks in the future. Furthermore, the subjects were limited to healthy people in their 20s. If the stress of the underlying disease is large, the stress of the mask may be canceled out, and in the future, it will be necessary to evaluate this in hospitalized patients who require oxygen therapy.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Chihiro Nishimoto conducted all of the experiments and wrote the submitted paper.
- Jun Yoshioka checked the paper.
- Kazuki Tomita, Shyungo Someya, Kazuma Suzuki, and Taizou Nakamura performed experiments.
- Hitoshi Kijima advised the study.

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No funding was received for this study.

Conflict of Interest

The authors declare no conflicts of interest relevant to the content of this article.

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APPENDIX

Table A.1 Seven mood scales from the POMS test

GB			DD			FI		
pre	post	Δ	pre	post	Δ	pre	post	Δ
34	37	3	40	42	2	37	45	8
39	44	5	43	45	2	42	50	8
30	32	2	42	38	-4	33	36	3
32	36	4	38	42	4	36	42	6
37	43	6	43	46	3	44	49	5
41	37	-4	45	45	0	50	45	-5
35	32	-3	38	38	0	36	37	1
30	30	0	40	40	0	34	36	2
39	35	-4	42	39	-3	37	41	4
35	31	-4	40	40	0	39	37	-2
37	35	-2	43	45	2	41	44	3
36	32	-4	42	41	-1	42	42	0
43	40	-3	46	45	-1	41	47	6
35	31	-4	39	41	2	36	36	0
37	37	0	42	45	3	41	47	6
36	34	-2	39	38	-1	39	45	6
39	32	-7	39	40	1	44	44	0
36	39	3	39	41	2	36	39	3
37	36	-1	43	42	-1	47	42	-5
37	36	-1	43	40	-3	37	37	0

VA			F			TM D		
pre	post	Δ	pre	post	Δ	pre	post	Δ
45	46	1	55	55	0	2	16	14
49	49	0	55	51	-4	18	39	21
59	37	-22	55	45	-10	-11	5	16
54	45	-9	62	55	-7	-12	19	31
44	45	1	47	53	6	21	40	19
49	49	0	59	57	-2	29	25	-4
39	37	-2	51	51	0	2	2	0
44	44	0	59	59	0	-3	-2	1
45	41	-4	47	45	-2	13	12	-1
44	41	-3	47	45	-2	8	4	-4
44	44	0	51	51	0	19	21	2
42	40	-2	47	49	2	17	9	-8
41	46	5	55	51	-4	32	30	-2
39	49	10	40	45	5	7	-3	-10
44	49	5	51	57	6	18	28	10
45	42	-3	59	55	-4	12	16	4
36	39	3	53	49	-4	22	9	-13
42	57	15	59	66	7	4	-1	-5
45	39	-6	66	59	-7	19	13	-6
49	51	2	59	59	0	10	1	-9