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The Effects of Facial Exercise on Mental Health, Facial Expression and EEG in Community-Dwelling Older Adults

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ABSTRACT

Although it is well documented that exercising is good for the mental health and cognitive function as well as the physical condition in elderly people, exercising is difficult in elderly individuals with a low motor function. To develop an exercise program targeting elderly individuals unsuited for whole-body exercises, we assessed the effects of facial exercises on the mental health and mood in healthy elderly people. Community-dwelling older adults (N = 75, age range = 65-87 yrs) were randomly divided into a facial exercises group and a wait-listed control group. A facial exercises program of 30 min was given twice a week for 12 weeks. This program consisted of rhythmic facial movement, muscle stretching, facial yoga, and Tanden breathing. The GHQ-12 for mental health were administered to both groups before and after the 12-week study period. In addition, facial expression and EEG were measured. Fifty-three participants completed the protocol. In the intervention group, the GHQ-12, facial expression, and α wave in frontal lobe improved post-intervention. These results suggest that facial exercises are effective in improving the mental health, facial expression, α wave in frontal lobe of elderly people, and that exercises may be useful as a therapeutic modality in this population.

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Introduction

In Japan, where a super-aging society is advancing, it is necessary to maintain and improve not only physical but also mental health by myself. As a one resort, although it is well documented that exercising is good for he mental health and cognitive function as well as the physical condition in elderly people, exercising is difficult in elderly individuals with a low motor function. To develop an exercise program targeting elderly individuals unsuited for whole-body exercises, we assessed the effects of facial exercises on the mental health, mood and brain function in healthy elderly people. Therefore, this study focused on facial exercise not physical exercise. The facial feedback hypothesis [1, 2]. States that facial movement may influence emotional experience [3]. Facial expressions for basic emotions (happiness, surprise, anger) have been found to be well-defined and universal across cultures [4]. Certain facial muscle movements can be controlled voluntarily, while others occur primarily during 'genuine' emotions. These two facial expressions are mediated by different neural pathways. Voluntary smiles are initiated in the motor cortex and routed via the pyramidal motor system, whereas involuntary smiles arise mainly from subcortical nuclei and are routed via the extrapyramidal motor system. An unexpected by-product of this research has been the observation that voluntarily producing and holding an expression can induce the corresponding emotion [5,6]. This effect is more pronounced when a person pays specific attention to voluntarily activating muscles that are usually only used involuntarily (e.g. the Duchenne marker) [7,8]. On the other hand, a study reported that botulinum toxin of the corrugator muscle resulted in decreased activation of the brain regions implicated in emotional processing and emotional experience (namely, the amygdala and the brainstem) [9]. The aim of this study, we assessed the effects of facial exercises on the mental health, mood, facial expressions and brain function in healthy elderly people.

Methods

Subjects

We recruited 75 people (age: 75.5±5.6, age range: 65-87) who posted posters in the welfare facility for the community-dwelling older adults inparticipated in the preliminary briefing session, and obtained their consent. In addition, the subjects were those who clearly had no dementia and were independent and engaged in daily activities.

Methods

Subjects were randomly assigned to the intervention group and the non-intervention group, and the intervention group was given the facial exercise 30 minutes once, twice a week, and 12 weeks (24 times in total) during the three months from April to June 2016. The facial exercise program implemented this time is a facial exercise

officially recognized by the British Preventive Medicine Institution and Health Exercise Instructors Association. The content is aerobic exercise that rhythmically performs acupressure of acupuncture points on the face, facial muscles training (including the muscles of tongue), facial yoga, facial lift massage, partly according to the Tanden breathing method, and exercise intensity is about 2.5 to 3 METs.

Measuraments

• General Health Questionnaire-12 (GHQ-12) (measured twice before and after intervention) Developed by Goldberg (1972), the Japanese version was prepared by Nakagawa et al. (1985), and its reliability and validity were reported by Niina et al. (2001) [10].

• Facial Expression Analysis (measured twice before and after intervention) Facial expression changes caused by the intervention were analyzed using facial expression analysis. This time, "FaceReader ™ (Noldus)" was used. By identifying, tracking, and 3D modeling 491 points in the face, the basic 6 emotions and neutrality of facial expressions are measured. Ogawa et al. (2012) reported that facial expressions of joy and neutrality matched the results of FaceReader ™ and VAS [11]. This time, before and after the intervention, I took a picture of the smile that appeared when I imagined my favorite food. The facial expression value of joy included in the smile was calculated, and if the value increased, it was evaluated as "improvement".

EEG analysis As a physiological index of intervention effect, changes in the degree of relaxation were investigated using alpha power; EEG amplitude squared [12]. The electroencephalograph used the emotion analysis system ESA-16Pro (NF Corpo-ration, Brain Functions Laboratory, Inc.). The EEG recording is performed in an awake, resting state with eyes closed for 3 min. This time, as the power of the alpha wave, the relative ratio(%) of the power of the alpha band(8-13Hz) to the power of the entire band of 5-20Hz at the electrode position(Fp1, Fp2, F3, F4) by the international 10-20 system was used. Because James and Rod(2014) reported activation of the frontal the alpha wave after exercise [13].

Statistics

Paired t-tests and a two-way repeated analysis of variance (ANOVA) were used to verify the difference between pre and post intervention variables within each group, and to test within-group effect of time and between-group differences. A value of $p < 0.05$ was considered to be statistically significant for all analyses.

Results

Of the subjects who gave consent, 25 subjects who participated in 80% or more of the intervention group and 28 subjects who participated in the measurement before and after the intervention were analyzed in the non-intervention group. A total of 53 people in the intervention group and non-intervention group (Age 75.5 ± 5.6, 65-87yrs) had 2 males (Age 72.0 ± 5.6, 71-73 yrs) and 51 females (Age 78.3 ± 5.7. 65-87 yrs). There were no significant differences in the basic attributes of gender, age, height, weight, BMI, housing pattern, activities of daily living, and cognitive function between the two groups before the intervention (Table 1). In addition, in the MMSE, there were no participants who suffered from cognitive decline and hindrance when

performing face exercises on their own (Table 1). Table.1 Demographic comparison of the intervention and control groups at baseline

Table 1: Demographic Comparison of the Intervention and Control Groups at Baseline

	Measure		Intervention (n=25)	Control (n=28)	p
Gender[a]	(Female:Male)	(n)			1.000
Age[b]	(Mean±SD)	(y)	74.6±5.3	76.3±5.9	0.302
Height[b]	(Mean±SD)	(cm)	151.5±6.7	150.1±6.0	0.452
Weight[b]	(Median(IQR))	(kg)	53.2(43.8-65.0)	52.0(37.4-60.8)	0.154
BMI[b]	(Median(IQR))	(kg/m^2	23.3(17.7-30.0)	22.5(16.8-27.4)	0.510
Dwelling Style[d]	(①single, ② couple, ③ more than 3families)	(n)	①13 ②8 ③4	①13 ②9 ③6	0.865
MMSE[c]	(Mean±SD)	(p)	28.5±2.8	28.2±2.0	0.193
ADL[c]	(Mean±SD)	(p)	11.9±2.0	12.3±1.3	0.454

Between groups comparisons : [a]Fisher exact test, [b]Unpaired t-test, [c]Mann-Whitney U test, [d]χ^2 test
Abbreviations: BMI:body mass index

Mental Health

First, a paired t-test was used for comparison before and after the intervention. As a result, the GHQ in the intervention group decreased significantly ($p = 0.003$). Then, a repeated two-way ANOVA was performed with the independent variable as the presence / absence of face exercise intervention (difference factor between groups) and time (time factor), and the dependent variable as each evaluation item, and GHQ ($F(1,51) = 9.171$, $p = 0.004$), interaction and simple main effect were observed (Table 2). Table.2 Comparison of group differences in changes on measure.

Table 2: Comparison of Group Differences in Changes on Measure

Measure	Group	Pre Mean±SD	Post Mean±SD	*F*	*p*
GHQ(p)	Intervention (n=25)	3.5±2.7	2±2.4**	9.171	0.004**
	Control (n=28)	1.8±1.8	2.1±2.4		

Between groups comparisons : Paired t-test, Two-way ANOVA **:p<0.01

Facial Expression

A paired t-test was used for comparison before and after the intervention. As a result, the facial expression ($p = 0.003$) of the intervention group showed a significant improvement. After that, repeated two-way ANOVA with the independent variable as the presence or absence of face exercise intervention (difference factor between groups) and time (time factor), and the dependent variable as each evaluation item was performed and examined, but no interaction was observed. It was not ($F(1,16) = 2.754$, $p = 0.116$) (Table 3).

Tabe 3: Comparison of Group Differences in Changes on Measure

Measure	Group	Pre Mean±SD	Post Mean±SD	*F*	*p*
Facial Expression (%)	Intervention (n=9)	29.9±17.7	61.9±21.5*	2.754	0.116
	Control (n=9)	49.0±21.3	59.2±24.7		

EEG

After 3 months of intervention, paired t-tests were used for changes in alpha wave content before and immediately after the intervention. As a result, a significant improvement ($p = 0.014$) was observed in the intervention group, but no significant change was confirmed in the non-intervention group.

Table 4: Changes in Frontal Relative Power of Alpha (%)

Group	Pre Mean±SD	Post Mean±SD	Interaction *F*	Interaction *P*
Intervention (n=8)	32.1 ± 3.9	43.6 ± 9.4*	7.976	0.014*
Control (n=8)	31.6 ± 3.8	29.4 ± 6.8		

Between groups comparisons : Paired t-test, Two-way ANOVA

*: $p<0.05$

Discussion

In this study, we conducted a randomized controlled trial to clarify the effects of facial exercise on the mental health of the elderly. From the results of the psychological scale

When the changes before and after the intervention were examined by a paired t-test, GHQ showed a significant improvement in the measurement 3 months after the intervention group. Interactions were confirmed in ANOVA. As a result of the simple main effect test, the intervention group showed that the intervention significantly reduced the GHQ. On the other hand, in the non-intervention group, the score increased slightly after 3 months, and no significant difference was observed, suggesting that mental health may have deteriorated slightly. Saito et al. (2007) reported that facial muscle stretching was performed on type 2 diabetic patients to improve stress and mood [14]. In addition, Uchida and Arai (2010) conducted facial muscle training and positive thinking training for Parkinson's disease patients, and showed significant effects on mental function and depression [15]. The results of this study suggest that facial exercise is effective for mental health even in healthy elderly people.

Effect on Facial Expression

The subject expressed a smile with the image of "favorite food". The smiles were taken before and after the intervention for 3 months, and the images were analyzed with a face reader. As a result, no interaction was observed between the two groups, but the intervention group showed a significant improvement in facial expression after the face exercise intervention, and when they felt joy, they were able to express a more happy facial expression. It was. According to Noguchi and Yoshikawa (2010), it is reported that facial expression disagreement, which is performed consciously and unconsciously on a daily basis, tends to be cognitively stressed and adversely affects the mental health of the person who expresses it [16]. On the contrary, it is possible that the expression of joy after this face exercise intervention may lead to the maintenance of mental health.

About The Effect on Eeg

In the EEG measurement, the alpha wave power of the frontal region before and after the intervention was compar-ed compar-ed from the obtained EEG. Alpha waves are mainly seen in arousal, rest, and closed eyes, reflecting a calm state both physically and mentally, and are suppressed by tension and mental instability [17]. In this study, alpha waves were measured 3 months after the intervention, immediately before and after facial movement, and a significant increase in alpha waves was observed in the intervention group. This suggests that facial exercise may have helped to stabilize mood. Although the frontal lobe function test was not performed this time, it is considered necessary to measure the cognitive function centering on the frontal lobe function in order to judge the effect.

Conclusion

The results of a randomized controlled trial with facial motor intervention were as follows.

1. The GHQ score of the intervention group decreased significantly after 3 months, and the score of the non-intervention group increased slightly and showed a tendency to worsen. This result suggests the usefulness of facial exercise in the mental health of the elderly.
2. After the intervention, the intervention group showed a significant improvement in facial expression, and when they felt joy, they were able to express a more happy facial expression.
3. Immediately after the intervention, the α wave content of the EEG was significantly higher in the intervention group than in the non-intervention group, and a relaxing effect was observed. In the super-aged society, not only to achieve longevity, but also to

maintain good physical independence function, stress management and mental health in daily life, and to maintain QOL. It is important to work on prevention. In this study, it can be said that we were able to confirm the improvement of mental health, relaxation effect and facial expression by performing facial exercises for healthy elderly people, and suggest the possibility as a behaviour modification approach to nurture exercise habits safely. Facial exercise can be performed not only for healthy people but also for frail elderly people, people with physical disabilities such as Parkinson's disease and cerebrovascular accidents, and people who have difficulty in performing physical exercise, and are expected to be effective. In the future, I would like to continue my research, accumulate further knowledge, and aim to develop a facial exercise program that has health benefits.

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