



Original Article

# Changes in oral health status and function among older adults through professional oral care and rehabilitation exercises

Ae-Jin Jeong<sup>1,4</sup>, Nam-Sook Kim<sup>2,4</sup>, Jung-Hwa Lee<sup>3,4</sup>

<sup>1</sup>Department of Dental Hygiene, Ulsan College

<sup>2</sup>Department of Dental Hygiene, Masan University

<sup>3</sup>Department of Dental Hygiene, Dong-eui University

<sup>4</sup>Oral Hygiene Science Research Institute, Dong-eui University

**Corresponding Author:** Jung-Hwa Lee, Department of Dental Hygiene, Dong-eui University, 176 Eomgwang-ro, Busanjin-gu, Busan-si, 47340, Korea. Tel: +82-51-890-4239, Fax: +82-505-182-6878, E-mail: yamako93@deu.ac.kr

## ABSTRACT

**Objectives:** To develop a program that combines the oral health promotion program for the elderly and to investigate the effect of improving oral function by applying the oral health promotion program to elderly people using welfare facilities. **Methods:** From June to October 2022, a total of 29 elderly individuals utilizing welfare facilities in the Gyeongnam region were recruited. The control group underwent surveys and objective oral health assessments. The experimental group participated in an oral health promotion program, consisting of oral functional rehabilitation exercises and expert oral health management, conducted once a week for 8 weeks at the facilities. Objective oral health assessments were conducted before, during (at 4 weeks), and after (at 8 weeks) the intervention period for both groups. **Results:** As a result of the oral health promotion program, it was confirmed that there was an improvement effect in bad breath ( $p<0.001$ ), saliva secretion amount ( $p<0.001$ ), orbicularis oculi muscle ( $p<0.001$ ), and plaque index ( $p<0.001$ ). **Conclusions:** A revitalization plan is needed so that the efficient oral health promotion program for the elderly can be reflected as a systematic and professional community care oral health management program.

**Key Words:** Elderly, Oral function rehabilitation exercises, Oral health promotion, Professional oral health care

## Introduction

According to data from the Health Insurance Review & Assessment Service, healthcare expenditures for older adults covered by health insurance increased by more than 1.5-fold between 2010 and 2015, from 14.135 to 21.921 billion KRW, placing a significant burden on the social security system [1]. In response to this increase, the Ministry of Health and Welfare established a task force in 2018 to build an integrated care service for vulnerable populations, as part of a comprehensive approach addressing the complex issues of an aging society. By 2020, they launched a pilot program—the Korean community care initiative—in 16 local governments, with Cheonan and Bucheon conducting home oral health interventions [2].

The oral cavity is an essential component of energy intake via mastication and plays a crucial role in overall health. Poor oral health can lead to systemic health deterioration, nutritional imbalances, and reduced quality of life, making oral health increasingly important as people age [3]. Among older adults, oral infections caused by apical and periodontal lesions, poor dentures, or restorations can escalate into life-threatening systemic infections [4] or increase the risk of cardiovascular disease, stroke, diabetes mellitus, and respiratory disease due to the spread of bacteria through the bloodstream [5].

Additionally, medications for systemic diseases often cause xerostomia in older adults, with 48.1% of individuals >65 years of age experiencing oral discomfort [6,7]. Xerostomia affects mastication, swallowing, pronunciation, and taste and can result in a burning sensation, leading to nutritional imbalances. A dry oral environment and poor oral hygiene can facilitate respiratory pathogen colonization in the oropharynx, increasing the risk of aspiration pneumonia, which has a mortality rate four times higher than that of general pneumonia in older adults [8,9].

Numerous studies have been conducted on oral health in the Korean population. Moon [10] reported improvements in halitosis and plaque index through a toothbrushing program. Choi [11] highlighted the effects of professional oral care, including toothbrushing and denture disinfection, on salivary secretion, halitosis, and bacterial count in long-term care hospital patients. Lee [12] demonstrated improvements in plaque, halitosis, tongue coating, and salivary secretion through professional oral care, including toothbrushing, scaling, denture cleaning, oral muscle and salivary gland massage, and tongue-cheek articulation exercises. Lee et al. [13] reported the benefits of oral exercises for residents of long-term care facilities, including increased repetition of swallowing and pronunciation, salivary volume, mouth opening, and cheek puffing. Kim and Lee [14] also observed improvements in muscle function through oral and tongue strengthening exercises.

Jang and Lee [15] documented the impact of a program promoting oral health which combined oral exercises and the Watanabe tooth-pick method of toothbrushing on pronunciation, swallowing, and salivary secretion in older adults. Moon [10] showed enhancements in plaque and gingival bleeding indices, halitosis, and oral moisture by providing toothbrushing videos and posting posters about facial muscle, tongue, and salivary gland stimulation exercises in long-term care units to encourage residents to practice these activities three times daily. Studies integrating both oral function exercises and professional oral care, however, remain limited.

Based on findings that party blowers promote the activation of nerves and muscles related to nasopharyngeal closure [16], in addition to being easy to obtain and entertaining, we chose party blowers as our instrument for this study. Additionally, the findings of Lee et al. [17] that gum chewing is effective for alleviating xerostomia, we opted to utilize gum chewing as well, to improve salivary secretion and buffering capacity in older adults.

This study aimed to provide foundational data on the oral health status and functional improvement of older adults through an 8-week program combining oral-motor exercises (tongue and orbicularis oris strength, salivary gland stimulation) and professional oral care (sponge brush, Watanabe method, modified bass method, dental floss, interdental brushing, gum massage). Our overall goal was to validate the effectiveness of oral health programs provided by care facilities and public organizations.

## Methods

### 1. Study participants

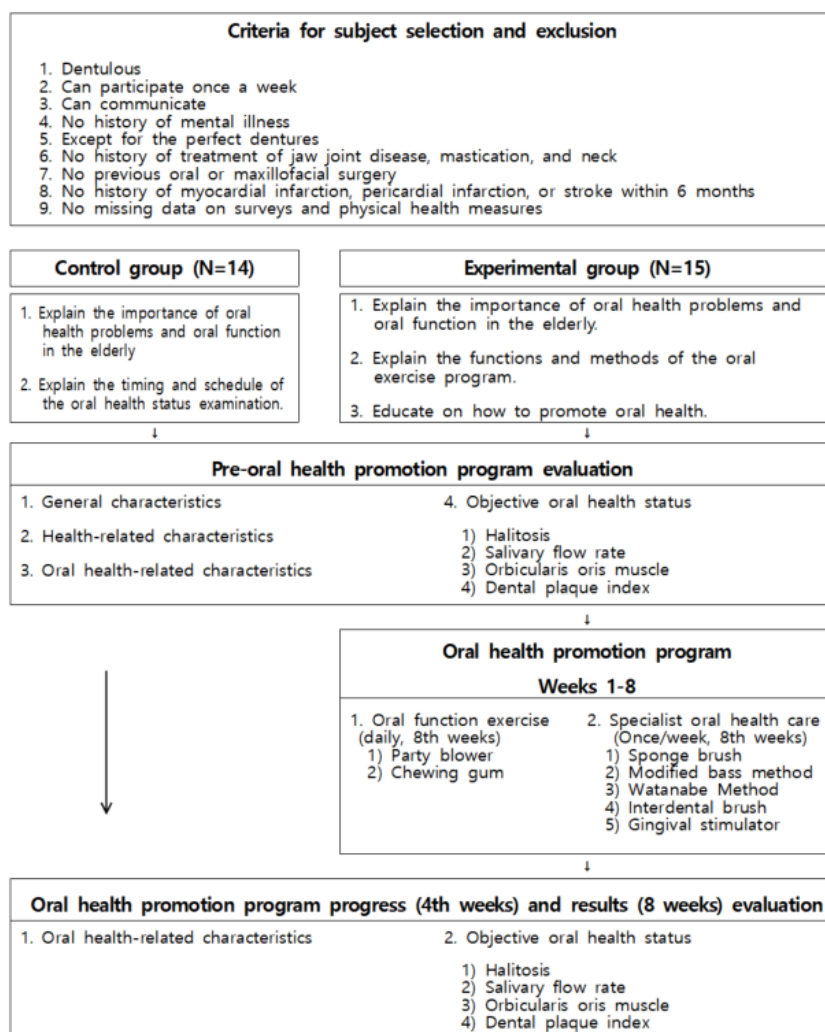
This study, conducted from June 2022 to October 2022, was approved by the Institutional Review Board of Dong-eui University (IRB No. DIRB-202205-HR-E-12) for the ethical protection of human subjects.

Older adults aged 65 years or older residing at the D Senior Welfare Center in Busan, Ulsan, and Yangsan E Senior Welfare Center in Gyeongsangnam-do who voluntarily provided informed consent to participate in the study were enrolled. After excluding edentulous individuals, those wearing complete dentures, and those diagnosed with coronavirus disease 2019 (COVID-19) during the program, the sample size was calculated using a sampling program (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany Power 3.19). For a moderate effect size of  $F=0.40$ , power=0.80, and significance level of  $\alpha=0.05$ , the minimum sample size was calculated to be 28. In consideration of a potential dropout rate of 30%, 36 patients were enrolled. After excluding 7 participants who did not complete the questionnaire and poorly attended the program sessions, 29 participants were included in the final analysis.

## 2. Study design

Each patient's general, health-related, and oral health-related characteristics were surveyed before the program. The control group was managed without intervention, while the experimental group received guidance on oral function exercises and professional oral health care.

The control group received objective oral health examinations (halitosis, salivation, dental plaque index, orbicularis oris muscle strength) and questionnaires before the oral health initiative started, week 4 and week 8, while the experimental group received guidance on oral function exercises and professional oral health care. Oral function exercises consisted of daily use of a party blower and gum chewing. Oral healthcare professionals visited the facility once a week for 8 weeks to provide sponge, Watanabe method, modified bass method, and interdental brushing, as well as flossing and gum massage. The experimental group underwent objective oral health examinations before starting the oral health program, weeks 4 and 8 of the program. The study flowchart is shown in <Fig. 1>.



**Fig. 1.** Research process

### 3. Methods

In this study, we assessed the objective oral health status after patients underwent a program which included professional oral care and oral function rehabilitation exercises. To minimize errors, both the researcher and research assistants were provided with detailed manuals and training on the measurement methods used before and after the program.

Participants were instructed to perform daily oral function exercises, including gum chewing and using a party blower. They were asked to place a sticker in a research diary (calendar) after each exercise session to track their adherence, which the researcher evaluated weekly to ensure compliance. Professional oral care was provided once a week for 8 weeks. The researcher and two assistants visited the senior residential centers weekly, from 9:00 AM to 11:30 AM, to provide oral care in the following order: sponge, Watanabe method, and modified bass method brushing, flossing, interdental brushing, and gum massage.

#### 1) Oral Functional Rehabilitation Exercises

##### (1) Party blower

The party blower used in this study refers to a device that forms the shape of an elephant's trunk when blown. The blower (9 cm internal diameter) is made of polyvinyl chloride (PVC) and is connected to a tube that measures 6 cm in length × 1 cm in thickness. Participants were instructed to blow the party blower for 10 seconds, four times per set. Two sets were performed in the morning and again in the evening. Participants were advised to rest sufficiently after each set to avoid respiratory muscle fatigue. They were also instructed to stop the exercise if they experienced breathing difficulties or dizziness, and to record the details in a sticker calendar.

##### (2) Gum chewing

Participants were instructed to chew a small piece of commercially available gum containing at least 67% xylitol for 20 minutes. For gum chewing, the subjects chewed commercially available gum containing more than 67% xylitol twice a day for 20 minutes and then spit it out.

#### 2) Objective oral health status

During the objective oral health examinations, we evaluated halitosis, salivation, orbicularis oris muscle strength, and dental plaque indices.

##### (1) Halitosis

Halitosis was measured using a handheld halitosis meter (HC-212S-WH; Tanita, Tokyo, Japan) as described by Joung [18]. The degree of halitosis was measured in six levels, ranging from 0 for no halitosis to 5 for very severe halitosis.

##### (2) Salivation

Salivary secretions were measured by having participants chew paraffin wax (Saliva-Check BUFFER; GC, Tokyo, Japan) for 5 minutes. The stimulated saliva was collected in a graduated test tube and the volume was recorded (ml).

##### (3) Orbicularis oris muscle strength

Orbicularis oris muscle strength was measured using an Oral Immunization Training Appliance (Litre Meter, Oral Academy, Tokyo, Japan) with a soft mouthpiece. Participants gently bit the mouthpiece with their upper and lower teeth, positioned it between their lips and teeth, and then pulled the Litre Meter device horizontally until the mouthpiece seemed about to slip out from their lips. At this point, the pulling force was recorded. Normal values for adults are around 2.0 kg, while for older adults, they are  $\geq 1.4$  kg. Scoring was based on the following guidelines: 1 point for  $< 1.0$  kg, 2 points for 1.0–1.49 kg, and 3 points for  $\geq 1.5$  kg [19].

##### (4) Dental plaque

Dental plaque was assessed using a modified Patient Hygiene Performance Index by Podshadley and Haley [20]. Six teeth (#16, 26, 36, 46, 11, 31) were covered with a solution and lightly brushed. The adherence of the dental plaque above the gingival margin

was then measured. Each tooth was scored as follows: 0 for no staining, 1 for staining in one area, and 5 for staining of the entire tooth.

## 4. Data analysis

The collected data were statistically analyzed using SPSS program (ver. 25.0; IBM Corp., Armonk, NY, USA), with a significance level set at  $p < 0.05$ . The normality of the oral health data was evaluated using the Shapiro-Wilk test. Results indicated that orbicularis oris muscle strength and salivary secretion volumes were normally distributed, allowing for parametric homogeneity tests. For non-normally distributed data, non-parametric methods were used for homogeneity testing. General characteristics and homogeneity of oral health status characteristics were analyzed using the Chi-squared test. The baseline homogeneity of oral health status (halitosis, salivary secretion volume, dental plaque index, orbicularis oris muscle strength) was assessed using independent sample  $t$ - and non-parametric Mann-Whitney U tests. Differences in oral health status before the program, at 4 weeks, and at 8 weeks were analyzed using repeated measures analysis of variance (ANOVA).

## Results

### 1. General characteristics and homogeneity

In terms of general characteristics, the control and experimental groups were found to be homogeneous, with no significant differences between the two groups among all variables ( $p > 0.05$ ) <Table 1>.

**Table 1.** Homogeneity test according to general characteristics Unit: N(%)

Characteristics	Division	Control group (N=14)	Experimental group (N=15)	Total (N=29)	$\chi^2$	$p^*$
Sex	Man	7(50.0)	3(20.0)	10(34.5)	2.885	0.095
	Woman	7(50.0)	12(80.0)	19(65.5)		
Age (yr)	≤65	3(21.4)	2(13.3)	5(17.2)	0.546	0.884
	66-75	7(50.5)	9(60.0)	16(55.2)		
	≥76	4(28.6)	4(26.7)	8(27.6)		
Education	Elementary	1(7.1)	4(26.7)	5(17.2)	2.906	0.236
	Middle school	5(35.7)	2(13.3)	7(24.1)		
	≥High school	8(57.1)	9(60.0)	17(58.6)		
Smoking	No	3(21.4)	2(13.3)	5(17.2)	0.333	0.651
	Yes	11(78.6)	13(86.7)	24(82.8)		
Presence of systemic disease	No	3(21.4)	5(33.3)	8(27.6)	0.514	0.682
	Yes	11(78.6)	10(66.7)	21(72.4)		

\*by chi-square test

### 2. Homogeneity of oral health status

There were no significant differences in halitosis, salivation, dental plaque index, and orbicularis oris muscle strength between the two groups, confirming homogeneity ( $p > 0.05$ ) <Table 2>.

**Table 2.** Homogeneity test of dependent variable

Variable	Division	Control group (N=14)	Experimental group (N=15)	Unit: Mean±SD	
				t/Z	p*
Objective oral health status	Bad breath <sup>†</sup>	2.21±0.70	2.47±0.74	0.837	0.451
	Salivary flow rate	6.00±1.66	6.33±2.09	-0.472	0.640
	Dental plaque index <sup>†</sup>	25.79±27.25	27.69±16.67	1.026	0.310
	Orbicularis oris muscle	0.90±0.38	0.64±0.36	1.886	0.070

\*by t-t est, †by Mann-Whitney U test

### 3. Improvement in oral function and oral condition before and after program

ANOVA was used to analyze the effects of the oral health promotion program on oral function and health status between the control and experimental groups before and after the intervention. The results indicated that halitosis significantly decreased in the experimental group, by 1.95 points, from 2.47 before the intervention to 1.20 at 4 weeks and 0.53 at 8 weeks ( $p<0.001$ ). The group and time interaction effect was significant ( $p<0.001$ ). Salivary secretion volumes in the experimental group increased significantly, by 0.93 points, from 6.33 before the intervention to 7.10 at 4 weeks and 7.27 at 8 weeks ( $p<0.001$ ). However, the group and time interaction effect was not significant. The dental plaque indices in the experimental group decreased significantly, by 15.06 points, from 27.69 before the intervention to 16.19 at 4 weeks and 12.63 at 8 weeks ( $p<0.001$ ). The group and time interaction effect was significant ( $p<0.01$ ). Orbicularis oris muscle strength in the experimental group significantly increased, by 0.93 points, from 0.64 before the intervention to 1.13 at 4 weeks and 1.57 at 8 weeks ( $p<0.001$ ). The group and time interaction effect was also significant ( $p<0.001$ ) <Table 3>.

**Table 3.** Test for differences in changes in bad breath, saliva flow rate, dental plaque index, and orbicularis oris muscle at each time point

Variables	Control group (N=14)			Experimental group (N=15)			F(p*) (Group)	F(p*) (Time ×group)
	Program pre-inspection	Program under inspection (4th weeks)	Program after inspection (8th weeks)	Program pre-inspection	Program under inspection (4th weeks)	Program after inspection (8th weeks)		
Bad breath	2.21±0.70	2.21±0.70	2.21±0.70	2.47±0.74	1.20±1.57	0.53±1.30	118.723 (<0.001)	18.487 (<0.001)
	md=0.00, p=1.000   md=0.00, p=1.000		md=-1.27, p<0.001   md=-0.67, p=0.003		md=0.00, p=1.000			
Saliva flow rate	6.00±1.66	6.07±1.44	6.21±1.48	6.33±2.09	7.10±2.74	7.27±2.58	377.228 (<0.001)	0.741 (0.482)
	md=0.07, p=0.880   md=0.14, p=0.761		md=0.77, p=0.103   md=0.17, p=0.713		md=0.21, p=0.679			
Dental plaque index	25.79±27.25	26.32±26.09	24.79±20.60	27.69±16.67	16.19±11.83	12.63±12.68	40.596 (<0.001)	6.353 (0.003)
	md=-0.53, p=0.851   md=-1.54, p=0.581		md=-11.49, p<0.001   md=-3.57, p=0.190		md=-1.01, p=0.781			
Orbicularis oris muscle	0.90±0.38	0.91±0.38	0.91±0.39	0.64±0.36	1.13±0.27	1.57±0.33	280.241 (<0.001)	50.294 (<0.001)
	md=0.01, p=0.912   md=0.01, p=0.895		md=0.49, p<0.001   md=0.44, p<0.001		md=0.01, p=0.854			

md: mean difference, \*by repeated measures ANOVA

Comparison between time points was performed using paired t-test.

## Discussion

This study aimed to develop an oral health promotion program consisting of professional oral care and oral function rehabilitation exercises for older adults, and to assess the effects of this program over an 8-week period as compared to a control group.

Repeated measures ANOVA showed a significant reduction in halitosis between the control and experimental groups after the 8-week oral health promotion program. Although Moon [10] did not find significant differences between the experimental and control groups, their results showed significant group and time interaction effects, in line with our findings. Moon [10], Lee [12], Park and Sohng [20], and Munro [21] all demonstrated the effectiveness of professional oral care in reducing halitosis and dental plaque indices, also in line with the results of this study.

Repeated measures ANOVA revealed significant differences in salivary secretion volumes between the two groups after the 8-week program, but no significant interaction effects between time points and groups. This suggests that while the experimental group showed an increase in salivary secretion, it was not significantly different than the control group. Studies by Jeon et al. [22] and Jang et al. [23] support these findings, indicating the need for continuous oral function improvement exercises to maintain increased salivary secretion, which helps reduce halitosis and improves swallowing, pronunciation, and tongue movement.

Repeated measures ANOVA showed significant differences in dental plaque indices after the 8-week program, as well as significant interaction effects between time points and groups. These findings are consistent with the study by Moon [10], which demonstrated the effectiveness of professional oral care, including the Watanabe toothbrushing method and interdental brushes, in managing dental plaque.

Repeated measures ANOVA indicated significant differences in orbicularis oris muscle strength after the 8-week program, as well as significant interaction effects between time points and groups. Studies by Kim and Lee [14] and Jang and Lee [15] reported improvements in swallowing disorders, swallowing power, and tongue pressure in older adults through combined oral exercises, which support our findings. This suggests that oral function rehabilitation exercises positively impact orbicularis oris muscle strength.

This study had a few limitations. Due to the COVID-19 pandemic, the program duration was limited to 8 weeks, and given that the study was conducted only in the Busan, Ulsan, and Gyeongnam areas, the findings have limited generalizability. Future studies should expand the program's implementation across different regions and extend the duration to at least 6 months to more thoroughly evaluate its effectiveness and validity as part of oral health policies for older adults.

## Conclusions

This study aimed to verify the effects of professional oral care and oral function rehabilitation exercises on the oral health status of older adults. The study included two groups: a control group of 14 participants and an experimental group of 15 participants. The experimental group received professional oral care and oral function rehabilitation exercises while the control group underwent evaluations and completed questionnaires. The key findings were as follows:

1. Halitosis significantly decreased, by 1.93 points, from 2.47 before the intervention to 0.53 after 8 weeks ( $p < 0.001$ ), with significant interaction effects over time ( $p < 0.001$ ).
2. Salivary secretion volumes increased by 0.93, from 6.33 before the intervention to 7.27 after 8 weeks ( $p < 0.001$ ). However, there were no significant interaction effects over time.
3. The dental plaque indices decreased significantly, by 15.06 points, from 27.69 before the intervention to 12.63 after 8 weeks ( $p < 0.001$ ), with significant interaction effects over time ( $p < 0.01$ ).
4. Orbicularis oris muscle strength increased by 0.93, from 0.64 before the intervention to 1.57 after 8 weeks ( $p < 0.001$ ), with significant interaction effects over time ( $p < 0.001$ ).

The results of this study indicate that professional oral care and oral function rehabilitation exercises significantly improved the objective oral health status (halitosis, salivary secretion volumes, dental plaque indices, orbicularis oris muscle strength) of older adults aged  $\geq 65$ . Therefore, applying the professional oral care and oral function rehabilitation exercise program used in this study in clinical and community settings could enhance both oral and overall health, in older adults. Accordingly, it is important to develop and integrate a systematic and professional community care oral health management program based on the professional oral care and oral function rehabilitation exercises utilized in this study.

## Notes

### Author Contributions

Conceptualization: AJ Jeong, NS Kim, JH Lee; Data collection: AJ Jeong; Formal analysis: AJ Jeong; Writing-original draft: AJ Jeong, JH Lee; Writing-review and editing: AJ Jeong, NS Kim, JH Lee

### Conflicts of Interest

The authors declare no conflicts of interest.

### Funding

None.

### Ethical Statement

The institutional review board of Dong-eui University (No. DIRB-202205-HR-E-12) approved the study, ensuring ethical protection for the participants.

### Data availability

Data can be obtained from the corresponding author upon reasonable request.

### Acknowledgments

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# 전문적인 구강관리와 재활운동을 통한 노인의 구강건강 상태와 기능의 변화

## 초록

**연구목적 :** 본 연구는 노인의 구강건강증진 프로그램 개발 및 적용에 따른 구강건강상태 개선효과를 확인하고, 노인의 구강건강증진 프로그램에 대한 기초자료를 제공하고자 하였다. **연구방법:** 부산광역시 부산진구 D노인복지시설 이용 노인과 부산, 울산지역을 포함한 경남지역의 노인복지시설 이용 노인 29명을 대상으로 하였으며, 실험군은 8주동안 매주 1회 시설을 방문하여 전문가 구강관리(스펀지 브러쉬, 변형바스법, 와타나베법, 치간칫솔, 잇몸마사지)를 제공하였고, 매일 구강기능향상운동(코끼리 피리 불기와 껌 저작)을 시행하도록 하였다. **연구결과:** 구취는시행 전 2.47점에서 시행 후 0.53점으로 감소하였고, 타액분비량은 시행 전 6.33점에서 시행 후 7.27점으로 증가하였으며, 타액완충능은 시행전 5.13점에서 시행 후 8.07점으로 증가하였다. 구륵근력은 시행 전 0.64점에서 시행 후 1.57점으로 구륵근력이 증가하였으며, 치은출혈지수는시행 전 18.11점에서 시행 후 9.94점, 치면세균막지수는 시행 전 27.69점에서 시행 후 12.63점으로 감소하여 노인을 대상으로 실시한 전문가구강관리와 구강기능향상 운동 프로그램이 노인의 구강건강증진과 향상에 효과가 있는 것으로 확인되었다. **결론:** 고령화시대 건강한 노인의 구강건강 뿐만 아니라 삶의 질 향상을 위해 노인의 건강증진 방안의 일환으로 전문가 구강관리와 구강기능향상 운동 프로그램을 적극 활용할 수 있는 방안이 모색되어야 할 것이다.

**색인:** 노인, 구강기능재활운동, 구강건강증진, 전문가 구강관리