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Original Article

Development and evaluation of a dental hygiene education program using scenario-based simulation method

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KEYWORDS

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Abstract *Background/purpose:* Scenario-based simulation education has been increasingly used in health professions to enhance clinical competence. However, its application in dental hygiene education remains limited. This study aimed to develop and evaluate a scenario-based simulation program focusing on oral care for elderly patients with systemic diseases to foster clinical skills.

Materials and methods: Participants were four fourth-year students and ten graduates from a dental hygiene course who completed a two-day session: the initial session and a follow-up session three months later. During the initial session, participants conducted the first practice, followed by debriefing and a second practice. Clinical skills were evaluated using an original 25-item checklist (maximum score: 47 points). Self-confidence was assessed using a 12-item questionnaire rated on a 10-point Likert scale at four time points: before and after each session. Changes in skills and confidence throughout the program were statistically analyzed.

Results: The median (interquartile range: IQR) total score of clinical skills significantly increased from 26.0 (24.0–28.3) at the first practice to 38.5 (35.8–40.3) at the second ($P < 0.001$), and was maintained with 35.5 (33.5–38.3) at follow-up practice. The median (IQR) total confidence scores were 49.5 (38.0–58.8) before and 71.5 (64.0–86.8) after the initial session, and 65.0 (54.0–72.3) before and 80.5 (74.3–87.5) after the follow-up session, indicating significant improvements through both sessions ($P < 0.01$).

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Conclusion: Scenario-based simulation education significantly enhanced clinical skills and confidence in oral care for elderly patients with systemic diseases, suggesting its educational value in dental hygiene education.

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Introduction

Since an aging society has been rapidly progressing in Japan and oral health is recognized to be essential for general health, oral health management by dental hygienists for elderly individuals requiring care and those with medical conditions has become a critical task.^{1–5} Accordingly, dental hygienist education is required to include clinical training on oral health management and multidisciplinary care of inpatients, and to encourage students to acquire these practical skills. However, opportunities for students to practice oral health care for patients in hospital settings are limited and involve high risks. These issues necessitate the use of alternative educational approaches.

As alternative education methods, a variety of simulation-based education using virtual reality, e-learning, and simulation rooms have been implemented, demonstrating the effectiveness of these methods, such as improving knowledge and increasing motivation for practices.^{6–11} Nevertheless, education programs specifically designed to replicate clinical settings and to strengthen practical skills are still scarce.

Therefore, we focused on “scenario-based simulation education,” an approach increasingly adopted in healthcare professional training in recent years, as a means to cultivate practical skills in settings that closely resemble clinical situations. Scenario-based simulation education is a learning method designed to enhance students’ clinical competencies by integrating the knowledge and skills they have acquired through practical experiences. These experiences are conducted using simulators and other tools to faithfully recreate realistic clinical settings based on actual scenarios. This method incorporates post-practice debriefing, during which students receive immediate feedback from evaluators and deepen their reflection through objective self-assessment, enabling them to apply these insights to subsequent practice. Thus, scenario-based simulation education serves as an effective approach for enhancing clinical practice skills and self-efficacy in practice, while eliminating the risks associated with direct patient interaction.

In nursing and other health professions, scenario-based simulation education has been widely implemented across the globe, as evidenced by numerous studies.^{12–17} In Morocco, approximately 63 % of nursing educators are reported to adopt this approach, indicating a notably high level of implementation.¹³ These practice reports suggest that this educational method not only enhances confidence in clinical practice but also effectively improves

interprofessional communication skills and further strengthens teamwork.^{15–17}

In contrast, scenario-based simulation education has been scarcely adopted in the field of dentistry. Although it has been applied in dental education for situations where actual clinical experience is difficult, including emergency response,^{18–20} only one report from Korea documents its use in dental hygienist education, specifically focusing on oral care for intubated patients.²¹

Therefore, this study implemented scenario-based simulation education within Japanese dental hygienist training programs as a means of cultivating clinical practice competencies and evaluated its educational effectiveness. The scenario theme was “oral health management for elderly patients with systemic diseases,” a topic in which acquiring practical skills through clinical experience is particularly challenging. We evaluated both the immediate educational impact and the sustained effect three months later. To assess the effectiveness of the program, we utilized instructor-assessed objective indicators of practical skills, in conjunction with self-reported confidence in clinical practice, generally used to measure educational impact.²²

Materials and methods

Participants

The participants comprised four fourth-year students and ten graduates of the bachelor’s program in dental hygiene at a medical university located in the Tokyo metropolitan area. Fourth-year students were included alongside graduates, because they had already learned oral health management for elderly patients with systemic diseases. All participants were female, because there were no males in the target population during the study period. The mean age (SD) of the participants was 24.1 (2.3) years. They provided informed consent to participate in the study and took part in a two-day program conducted on two separate occasions: the initial sessions and a follow-up session three months later.

This study was approved by the General Human Subject Research Ethics Committee of Institute of Science Tokyo (formerly Tokyo Medical and Dental University; approval number: C2023-064). All participants were informed about the purpose of this study and the protection of personal information using explanatory leaflets. Written consent to cooperate in this study was obtained from individuals who were willing to participate.

Structure of the educational program

The educational program in this study was developed based on the NLN/Jeffries Simulation Framework.²³ The design and implementation of the program is presented in Figure 1.

Scenario creation

The scenario theme focused on oral health management for elderly patients with systemic diseases and was designed to enhance clinical judgment and practical skills. The scenarios were created with reference to the manual for management of oral health under medical and dental collaboration²⁴ and several case reports on cardioembolic stroke,^{25–27} (Table 1). The clinical case involved a hospitalized female patient with left-sided upper and lower limb paralysis due to cardioembolic stroke, unconsciousness, and poor oral hygiene status.

Oral care practices based on the scenario

The participants performed oral care three times on two separate days: 1st and 2nd practices on the initial day, and follow-up (FU) practice on the day three months later. Participants first read the presented scenarios and built up the procedures necessary for oral care. Participants implemented oral care using the vital sign monitoring

equipment and the oral care simulator MANABOT® (Nissin Dental Products Inc., Kyoto, Japan) that faithfully replicates the oral cavity of hospitalized or bedridden elderly patients. The nurse role was assigned in a setting modeled after the realistic clinical environment. The participant's practice was recorded on video for later reflection.

Immediately after the 1st practice, the debriefing was conducted, where the participants reviewed their performance reflecting recorded footage and received feedback from two evaluators. Following the debriefing, the participants performed oral care again based on the same scenario (the 2nd practice). Three months later, participants performed oral care based on a new, similar scenario with slightly changed patient's condition (FU practice). After the practice, participants received verbal feedback from the evaluators.

Evaluation of clinical practice skill and self-confidence level

To evaluate the clinical practice skills objectively, an original checklist was created according to the scenario (Table 2). The checklist consisted of 25 items, with each item rated on a 2–4 point scale and a maximum total score of 47 points. Clinical skills in all practices were evaluated by two dental hygiene instructors using the aforementioned checklist. To ensure the reliability of the evaluation, calibration and standardization of scores for each evaluation

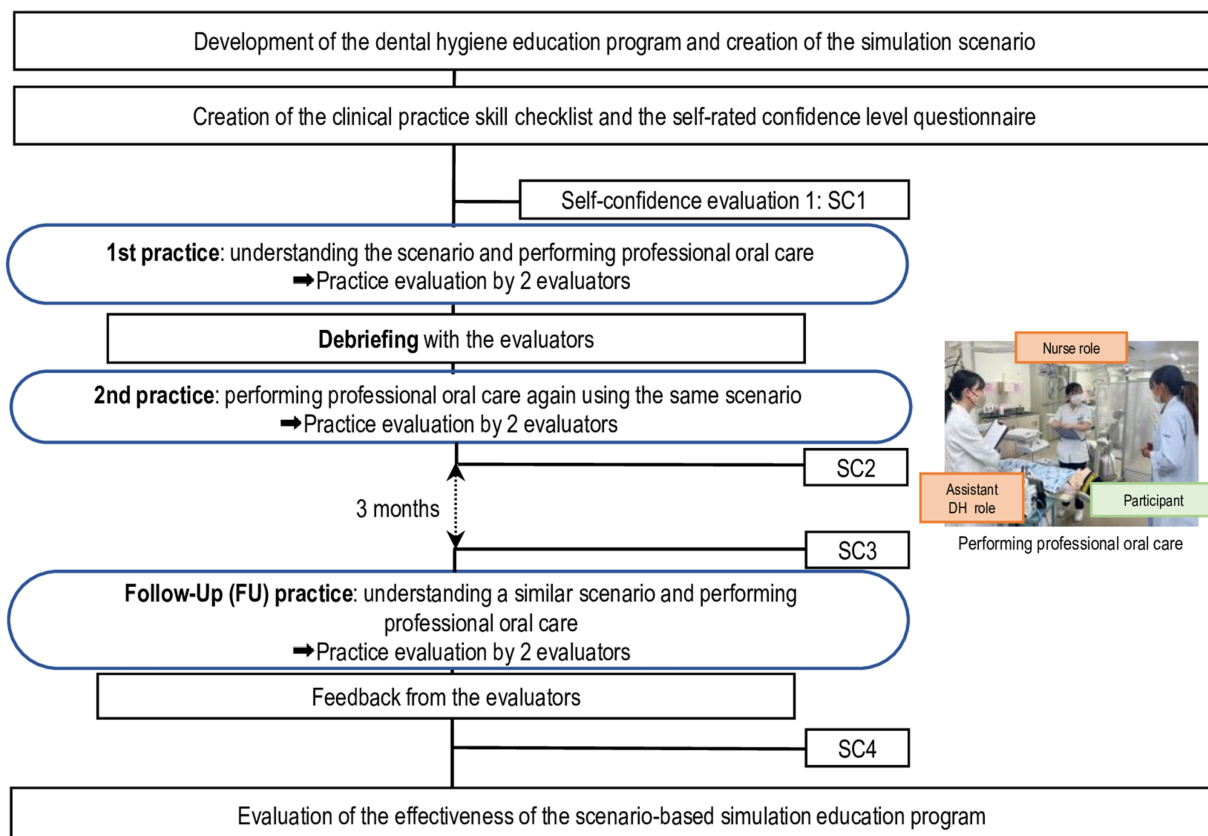


Figure 1 Development and evaluation process of scenario-based simulation education program. SC, self-confidence evaluation; DH, dental hygienist.

Table 1 Overview of the scenario.

Item	Description
Patient	Female, 87 years old; Height: 157 cm; Weight: 45 kg; BMI: 18.3
Primary diagnosis	Cardioembolic stroke
Present condition	- Left hemiplegia - Unstable respiratory status, Oxygen supply - Deep coma: minimal response to pain stimuli - Nasogastric tube feeding
Medical history	Hypertension, Atrial fibrillation
Medications	Amlodipine, Apixaban, Heparin continuous infusion (after admission)
Oral condition	- Poor oral hygiene with sputum and exfoliated epithelium - Severe xerostomia - Mobile anterior teeth - Oral hypersensitivity, Difficulty maintaining mouth opening - Oral care once a day by nurses
Dental hygienist intervention	No previous intervention
Setting and task of dental hygienist	A dental hygienist working at a hospital, instructed by a dentist to provide professional oral care in the ward. The participants are instructed to prepare the necessary instruments and perform oral care.
BMI, body mass index	

item between two evaluators were conducted before the program execution.

Participants' confidence in oral care was assessed using a self-administered questionnaire comprising 12 items, where each item was rated on a 10-point Likert scale, with 1 indicating 'not confident at all' and 10 indicating 'very confident'. Self-confidence evaluations were conducted at four different times: before the 1st practice (SC1) and after the 2nd practice (SC2), as well as before and after the FU (SC3 and SC4).

Statistical analysis

To examine the educational effects of the program, changes in clinical practice skills and self-confidence levels over time were analyzed using the Friedman test and Cochran's Q test. When significant differences were observed, multiple comparisons were performed with Bonferroni correction. All analyses were performed using SPSS Ver. 29 (IBM Corp., Armonk, NY, USA), and a *P*-value less than 0.05 was considered statistically significant.

Results

Changes in clinical practice skills and self-confidence levels through the program

The median (interquartile range: IQR) of total score of clinical practice skills was 26.0 (24.0–28.3) at the 1st practice, 38.5 (35.8–40.3) at the 2nd practice, and 35.5 (33.5–38.3) at the FU practice, demonstrating a significant increase from 1st to 2nd practices ($P < 0.001$) and a maintaining of an increased level at FU practice (Figure 2A).

The median total score for self-confidence (IQR) significantly increased from 49.5 (38.0–58.8) at SC1 to 71.5 (64.0–86.8) at SC2 ($P = 0.003$). A significant increase was also observed from 65.0 (54.0–72.3) at SC3 to 80.5

(74.3–87.5) at SC4 ($P = 0.003$), with the overall change from SC1 to SC4 reaching statistical significance ($P < 0.001$) (Figure 2B).

Changes in individual components of clinical practice skills and self-confidence through the program

Figure 3 illustrates the distribution of points for individual components related to professional oral care techniques and other essential skills for professional oral care across the three practices. Among oral care-related techniques, significant improvements were observed in lip moisturizing ($P = 0.043$), use of a bite block ($P = 0.014$), and post-intervention body positioning ($P = 0.043$) from the 1st to the 2nd practice. Furthermore, the elevated skill levels in lip moisturizing and post-intervention body positioning were maintained at FU. Regarding other oral care-related skills, significant improvements were seen in general physical assessment before ($P = 0.001$), during ($P = 0.042$), and after oral care ($P = 0.018$), preparation of necessary equipment ($P = 0.005$), and sharing oral information with the nurse ($P = 0.042$) from the 1st to 2nd practice. In addition, the improved skills in general physical assessment before ($P = 0.024$) and after ($P = 0.004$) oral care were sustained at FU compared with at the 1st practice.

Changes in self-rated confidence in respective items across the four evaluation points are shown in Figure 4. From SC1 to SC2, 10 items showed significant increases ($P < 0.05$). Additionally, all 12 items demonstrated significant increases in self-confidence from SC1 to SC4 ($P < 0.001$). Comparison between SC2 and SC3 with a three-month interval showed no significant differences in 11 items, while the item "Sharing information with other professionals" showed a significant decrease ($P = 0.041$).

Table 2 Clinical practice skill checklist.

	Before professional oral care
1. Confirmation of the patient's condition with the nurse	0: No verbal confirmation 1: Informed the nurse about the intervention 2: Informed the nurse about the intervention and confirmed the patient's condition
2. Communication with the patients before intervention	0: Begin silently 1: Greeted only 2: Greeted and explained procedure
3. General physical assessment before intervention	0: Not checked 1: Checked monitor 2: Recorded the monitor values or reported them to the assistant 【Recorded contents <input checked="" type="checkbox"/> 】 <input type="checkbox"/> Blood pressure <input type="checkbox"/> Pulse rate <input type="checkbox"/> Respiratory rate <input type="checkbox"/> SpO ₂
4. Wearing personal protective equipment	0: Wore nothing 1: Wore a mask and gloves 2: Wore a mask, gloves, and eye protection 3: Wore a mask, gloves, eye protection, and a medical gown
5. Posture adjustment before intervention	0: Not performed 1: Neck fixed 2: Adjusted to semi-Fowler's position or lateral position
6. Oral health assessment with OHAT-J	0: Not performed 1: Assessed with OHAT-J 2: Assessed with OHAT-J and recorded the score
7. Preparation of necessary supplies	0: Only toothbrush 1: Toothbrush, cup, and gauze 2: Toothbrush, cup, gauze, and mucosa care tools 3: Prepared all equipment listed below <input type="checkbox"/> Cup <input type="checkbox"/> Gauze <input type="checkbox"/> Soft-bristled toothbrush <input type="checkbox"/> Moisturizer <input type="checkbox"/> Oral swabs <input type="checkbox"/> Wet wipes <input type="checkbox"/> Bite block <input type="checkbox"/> Interdental brush <input type="checkbox"/> Denture brush <input type="checkbox"/> Portable light
8. Implementation of desensitization	0: Not performed 1: Performed but with issues 2: Properly performed
	During professional oral care
9. Talking to the patients during the intervention	0: Not performed 1: Appropriately performed
10. General physical assessment during intervention	0: Not performed 1: Checked the monitor 2: Checked the monitor and reported it to the assistant
11. Moisturizing the lips	0: Not performed 1: Performed
12. Moisturizing the oral cavity	0: Not performed or improperly performed 1: Properly performed
13. Cleaning of the oral mucosa with a swab	0: Not performed 1: Performed with improper pressure 2: Performed with appropriate pressure 3: Performed with appropriate pressure from back to front
14. Toothbrushing technique	0: Careless brushing 1: Brushing with appropriate pressure 2: Brushing with appropriate pressure, avoiding the cheeks and lips
15. Interdental cleaning with interdental brushes	0: Not performed 1: Roughly performed 2: Carefully performed
16. Consideration for mobile teeth during brushing	0: No consideration 1: With controlled pressure 2: Supported the tooth
17. Use of a bite block	0: Not used 1: Improperly used 2: Properly used
18. Mouth cleaning with wet wipes	0: Not performed 1: Improperly performed 2: Properly performed
19. Proper denture cleaning	0: Not performed 1: Rinsed under running water 2: Brushed with denture brush or toothbrush under running water
20. Insertion of the denture	0: Not performed 1: Performed
	After professional oral care
21. General physical assessment after intervention	0: Not checked 1: Checked monitor 2: Recorded the monitor values or reported them to the assistant

Table 2 (continued)

22. Posture adjustment after intervention	0: Not performed 1: Performed
23. Proper disposal of used equipment	0: Improper waste sorting 1: Proper waste sorting 2: Proper waste sorting and restoration of the surrounding environment
24. Communication with the patient after intervention	0: Left the room without saying anything 1: Explained and greeted before leaving
25. Sharing oral health information with the nurse	0: Not performed 1: Shared the patient's oral health condition 2: Provided suggestions to improve the patient's oral health condition

OHAT-J, Japanese version of oral health assessment tool; SpO₂, Saturation of percutaneous oxygen.

Discussion

In this study, we developed and implemented a scenario-based simulation education program for dental hygienists, focusing on oral health management in elderly patients with systemic diseases, and evaluated its educational effectiveness. As a result, total scores for clinical practice skills significantly improved in the 2nd practice following debriefing, and this improvement was sustained at FU. Similar immediate and sustained educational effects have been reported in the medical field,^{28–30} supporting the usefulness of this educational method for fostering clinical practice skills.

In the item-specific analysis of clinical practice skills, basic techniques such as toothbrushing and mucosal cleaning with a swab demonstrated relatively high points from the 1st practice, suggesting that these fundamental techniques had been acquired through conventional

educational methods. In contrast, several other skills—including general and oral assessments, posture adjustments before and after intervention, use of a bite block, lip moisturizing, and sharing oral health information with nurses—were insufficient in the 1st practice. Among these, all items except the oral assessment using the Japanese version of the oral health assessment tool (OHAT-J) showed significant improvement in the 2nd practice. Furthermore, lip moisturizing, posture adjustment after intervention, and general assessments before and after intervention maintained elevated levels at the FU even three months later. Although a previous nursing study conducted using a simulator primarily designed for whole-body management and emergency response reported no significant improvements in skills of lip moisturizing or posture adjustments,¹² the present study demonstrated clear educational benefits in these items. One possible explanation for this discrepancy may lie in the difference

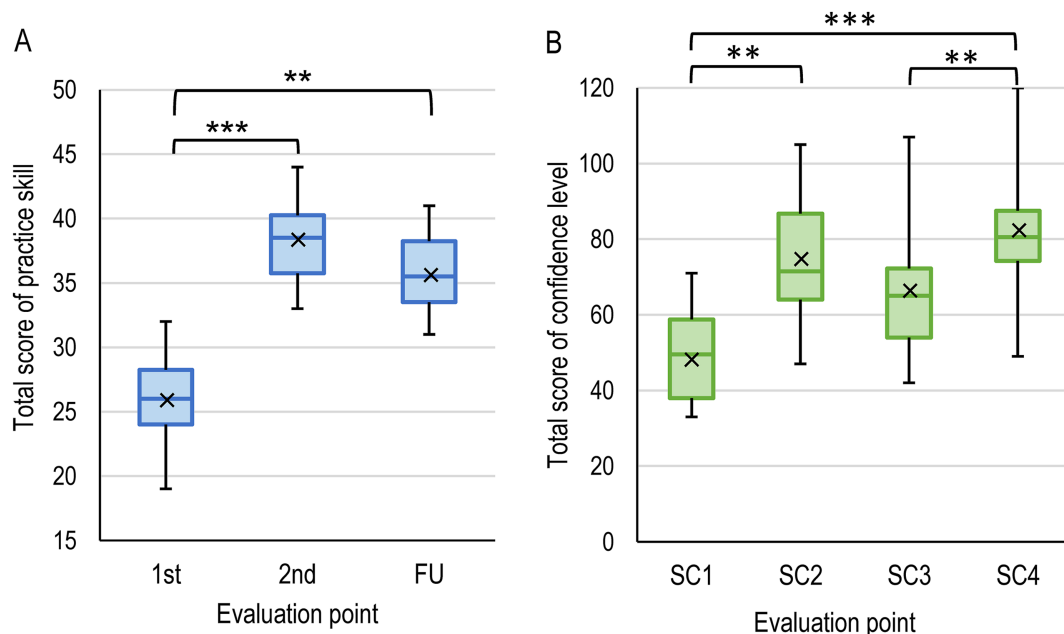


Figure 2 Changes in total scores of clinical practice skills (A) and self-rated confidence levels (B) across time points. The box plot represents the median and quartiles. The mark x indicates the mean value. Differences in total scores were analyzed using the Friedman test, followed by post-hoc comparisons adjusted with the Bonferroni correction. *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$.

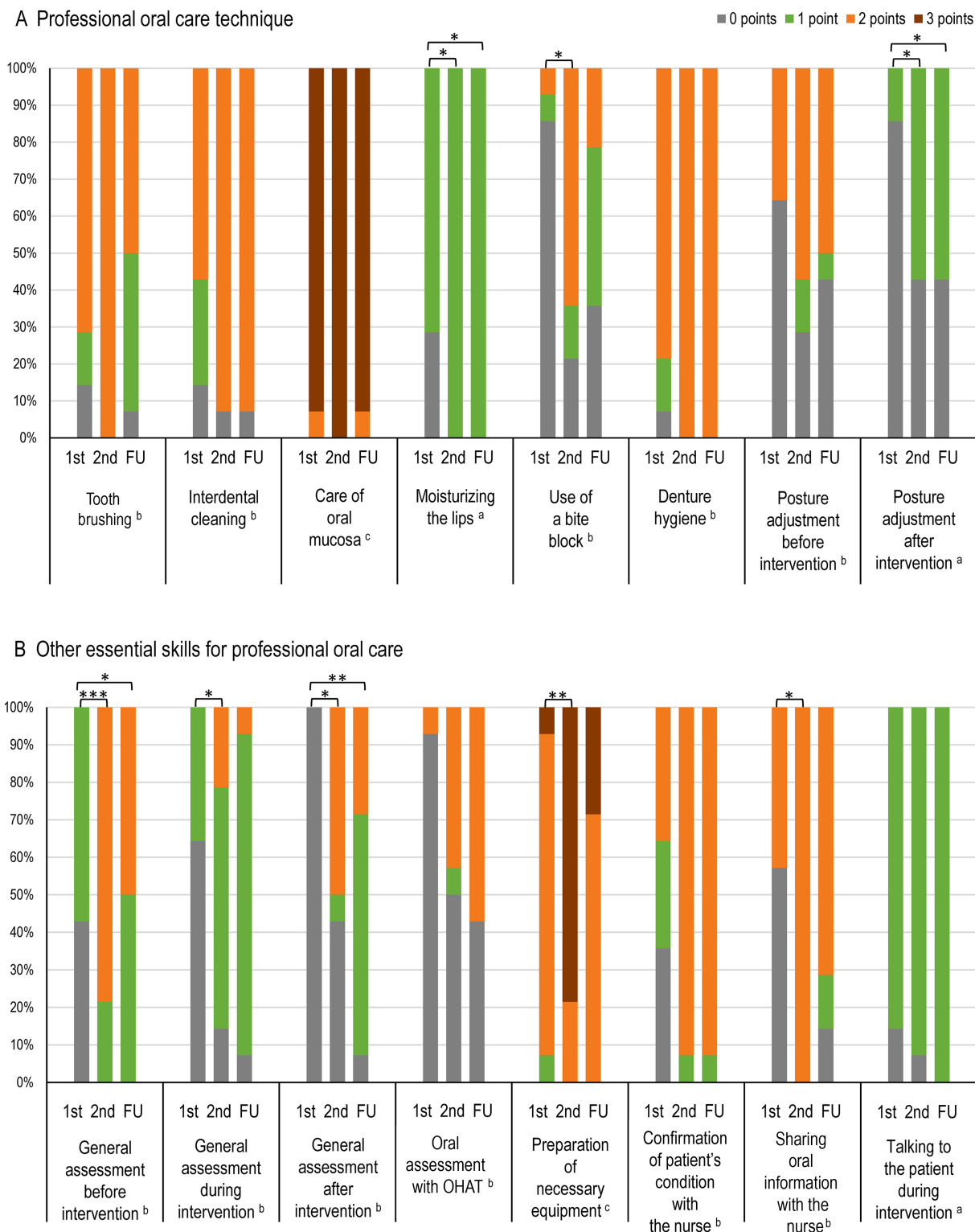


Figure 3 Changes in the distribution of evaluation points for individual components related to professional oral care techniques (A) and other essential skills for professional oral care (B) across the 1st, 2nd, and FU (follow-up) practices. Differences were analyzed using Cochran's Q test for dichotomous items (a) and the Friedman test for ordinal items with three (b) or four (c) evaluation options. Post-hoc analyses were conducted using the Bonferroni correction for multiple comparisons. *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$.

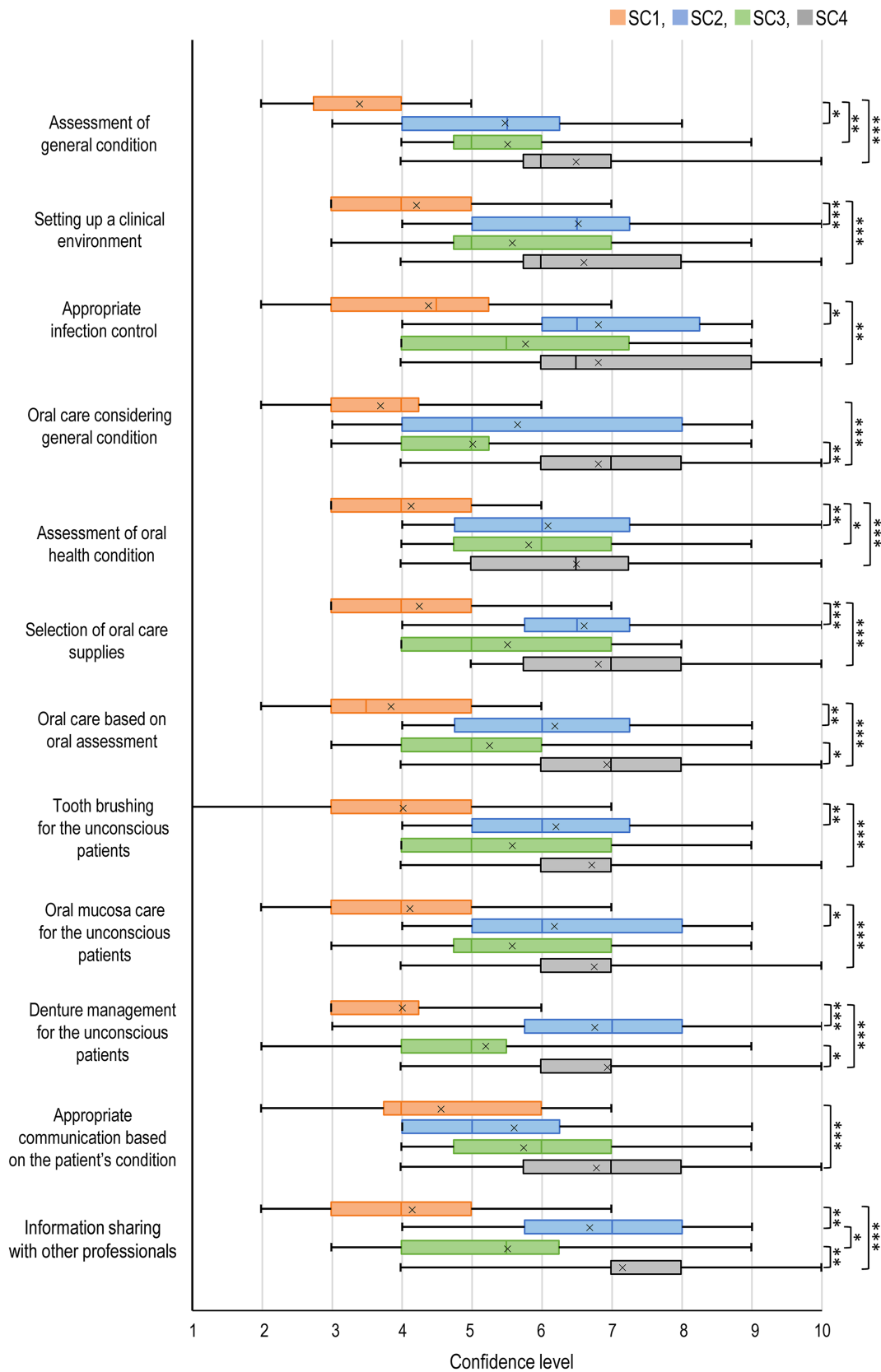


Figure 4 Changes in self-rated confidence levels for each item across the four time points. The box plot represents the median and quartiles. The mark x indicates the mean value. Differences across the four time points were analyzed using the Friedman test, followed by post-hoc comparisons with the Bonferroni correction. SC1 and SC2, self-confidence evaluation before and after the first session; SC3 and SC4, self-confidence evaluation before and after the follow-up session *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$.

between simulator types. As simulator fidelity influences learning outcomes,^{31,32} the positive effects observed in this study may be partly attributable to the use of a simulator specifically designed to replicate the oral environment of hospitalized or bedridden older adults. Additional contributing factors include the participants' high level of motivation and the evaluators' backgrounds as dental hygienists with substantial educational experience, which enabled them to provide specialized feedback.

Conversely, no significant changes were observed for oral health assessment using the OHAT-J throughout the program, with over 40 % of participants not utilizing OHAT-J for assessments. Although the actual use of OHAT-J did not increase, participants' self-confidence in oral assessments significantly improved. One possible explanation is that participants may have recognized oral health screening without OHAT-J as sufficient for oral care practice and may not have fully understood the significance of OHAT-J as a tool for interprofessional collaboration.^{33,34} Therefore, in the debriefing session, it is essential to provide feedback emphasizing OHAT-J use for facilitating interprofessional collaboration.

Regarding self-confidence level in oral care practice, the total score markedly increased from SC1 to SC2, was maintained at SC3, and further improved at SC4. While immediate improvements in confidence have been reported in simulation-based education for healthcare professionals,^{16,17,21,29,35} this scenario-based simulation program demonstrated not only immediate effects but also sustained effects.

By individual items, significant improvements from SC1 to SC2 were observed in all items except two: "Appropriate communication based on the patient's consciousness and cognitive function," and "Oral care based on changes in the patient's general condition." The lack of improvements in these items may be explained by limitations in the fidelity of the simulator and vital sign monitoring. Since the simulator did not respond to participants' verbal interactions, it was difficult for them to evaluate the appropriateness of their communication and enhance confidence. Additionally, the vital sign monitor did not exhibit realistic changes according to the patient's general condition, which may have hindered confidence increase in this item. Although immediate improvements in confidence levels in these two items were not observed, overall gains from SC1 to SC4 were evident across all items, including these two, suggesting that repeated practice is effective in building confidence in oral care. This finding also suggests that further improvement of simulators and monitoring with higher fidelity in replicating patient responses may achieve greater educational effects.

Focusing on changes from SC2 to SC3, a decline in self-confidence was observed only in the item "sharing information with other professionals." This trend aligns with previous studies reporting that self-efficacy temporarily decreases following initial simulation-based education, but improves with repeated learning opportunities.^{36,37} Information sharing with other professionals requires not only basic communication skills but also the advanced ability to convey specialized information clearly and accurately to professionals with different backgrounds. This higher-level communication skill may be difficult to develop

confidence through a single session, and likely requires repeated training.

This study has several limitations. First, it was conducted at a single university with a relatively small sample size, which limits the generalizability of the present findings. Second, clinical practice skills were evaluated using a checklist developed by the authors, and hence, further examination of its validity and reliability is needed. Another limitation of this study is that the effectiveness of the educational program was not compared with conventional methods, such as video-based learning. To more clearly demonstrate its effectiveness, future studies should include comparisons with a conventional education control group.

Despite these limitations, this study provides valuable insights into the effectiveness of the scenario-based simulation method in dental hygiene education. In particular, the program demonstrated usefulness in fostering clinical practice skills and enhancing confidence in oral health management for elderly patients with systemic diseases. Moreover, the sustained effects observed three months post-intervention underscore the potential long-term benefits of this educational approach. Although improvements in interprofessional collaboration skills and related confidence were not significant, enhancing debriefing strategies and refining simulator functions may help achieve greater impact in these skills and confidence. This scenario-based simulation program focused on oral health management for acute stroke elderly patients. In the future, this program can further incorporate diverse scenarios involving patients in intensive care units, end-of-life care and emergency situations that are difficult to experience in clinical settings, thereby offering an even more effective approach to strengthening the clinical competence of dental hygiene students and dental hygienists.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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