Virtual Reality Training System on Oral Health Care for Dependency Elderly in Oral Hygiene Students: A Randomized Controlled Trial

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Study protocol

Background

VR explores the revolution in medical training during COVID-19, when face-to-face training is not possible during a nationwide lockdown. VR can ease the burden and train medical professionals much more effectively than the traditional training methodologies[1]. Virtual reality (VR) has been proposed as a promising technology for higher education since the combination of immersive and interactive features enables experiential learning. Medical and healthcare students have limited opportunities to practice such skills in their clinical placements due to a lack of supervision and relevant practicing situations[2]. At present, VR is regarded as a training tool that can effectively train and implement and has been widely used in professional medical operations[3]. A previous study found that a VR training system provided students with better learning outcomes and self-confidence[4]. VR may also help improved knowledge retention, increase motivation to study, and decrease the fear of learning new things[2].

According to United Nations statistics [5], it is estimated that 15% of the population worldwide or some 1 billion individuals live with one or more disabling conditions. More than 46 per cent of older persons – those aged 60 years and over— have disabilities and more than 250 million older people experience moderate to severe disability. Taiwan has reached an age society in 2018 and the elderly population accounts for 14.1% of the total population and is expected to enter a super-aged society in 2025[6]. Poor oral health gives rise to considerable problems that impact both on an individual's well-being and quality of life as well as increasing the risks of general health issues[7]. Studies have pointed out that providing professional oral care can help reduce the risk of respiratory infections in elderly[8, 9]. An intervention study from Japan suggested that providing professional oral health care (POHC) by dental hygienists reducing prevalence of fever and is effective in preventing respiratory infections in elderly persons requiring nursing care[10]. The oral hygiene students expect to become professionals who can provide oral care for the elderly in the future. In their development education, it is imperative to strengthen their oral care skills for the elderly. With the strengthening of their skills, they will increase their self-efficacy. Possess professional oral care for the elderly to facilitate the implementation of oral care for the elderly in clinical work in the future. Oral hygiene students should not only have the correct oral health care knowledge and skills but should further learn to be effective in the subsequent clinical practice or work in the correct choice of oral care instruments, demonstrating and teaching patients or caregivers how to perform oral

health care properly, and then promote patient health care outcomes [11]. In addition to knowledge, there are also a series of operation steps and related equipment selection for the education and guidance of oral care. Therefore, it may be more difficult for students to have opportunities for self-operation and practice by simply teaching or demonstrating in class. Traditional physical teaching aids are also more challenging to simulate situations and even more challenging to have coherent step-by-step learning to overcome the difficulty of traditional teaching methods to achieve situational simulation and a series of practical exercises.

VR, in particular, has been adopted across medical and nursing fields as a method to educate medical students on some professional topics that require operational learning, such as emergency first aid, basic life-saving techniques, surgical skills training, learning systematic clinical observation and fire safety; the results show that the effectiveness is no less than that of using traditional teaching aids, especially the effectiveness of operating skills [12-14]. No study has developed and evaluated the effects of implement VR applications to train oral care professionals. We therefore developed the first VR system used in professional oral care training, which allows users to self-practice the elderly oral care skill in an immersive and interactive cave VR system (Pvix VR, EPED Inc.). The dependency elderly seniors are selected as the training objects in this VR training system because they were high risks groups, and the elderly's safety cannot be guaranteed if the students have not undergone sufficient practice and training. Therefore, we aimed to evaluate the effectiveness of VR-based training on oral health care for the dependency elderly among oral hygiene students.

Methods

2.1. Design and Participants

A randomized controlled trial (RCT) was conducted. The protocol was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (reference numbers: KMUHIRB-SV(II)-20200071). All students provided informed consent before the participation.

A total of 23 students from the third grade of Department of Oral Hygiene students in Kaohsiung Medical University during the 2021 academic semester were recruited in the present study. Participants have to take both the courses of 'Basic Medical Nursing Care' and 'Oral Health Care for Community People and Long-term Care Residents' before intervention. Eleven students were randomized in the virtual-reality experimental group (EG) and 12 in the control group (CG).

2.2. Randomization and Allocation

Students were randomly assigned to the virtual-reality experimental (EG) group and control group (CG). We used the random table from Excel with a ratio of 1:1 to accomplish the randomization. An open-label experimental design was used; students

were wise to the group they were allocated in.

2.3. Instrument

A structured questionnaire related to elderly oral health was developed to collect data on five parts: (1) demographics (i.e., gender, age), (2) oral care-related knowledge, (3) attitude toward oral care, (4) self-efficacy toward oral care (5) intention to oral care behaviors. A panel of experts reviewed items to assess content validity. The content validity index was 0.97-1.00. The reliability of each scale was assessed in terms of internal consistency (Cronbach's alpha coefficient). The satisfaction survey was based on System Usability Scale (SUS) to measure the usability of the VR-based learning system the students used during the oral care training. The SUS covered the effectiveness (the ability of users to complete tasks using the system, and the quality of the output of those tasks), efficiency (the level of resource consumed in performing tasks), and satisfaction (users' subjective reactions to using the system) [15].

2.4. Outcome Measures

2.4.1. Elderly oral care-related knowledge

Twenty items measured elderly oral care-related knowledge; for example, 'There is no need to consider the size of the interdental brush.' Possible responses included True (1), False (0), and I do not know (0), with possible scores ranged from 0 to 20; a higher score indicated a higher degree of oral-care-related knowledge. The KR-20 coefficient was 0.56 for this scale.

2.4.2. Attitude toward elderly oral care

Seven items measured attitude toward elderly oral care, for example, 'Assist disabled elderly to clean their teeth is annoying.' Each item was scored on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Possible scores ranged from 5 to 35; a higher score indicated a more positive attitude toward oral care for the elderly. Cronbach's alpha was 0.70 for this scale.

2.4.3 Self-efficacy of elderly oral care

Eleven items were used to evaluate the self-efficacy of elderly oral care. Students indicated their degrees of agreement with statements related to perceptions of personal ability concerning oral care for the elderly. For example, 'I am confident to remind disable elderly having regular dental visits every six months.' Each item was scored on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Possible scores ranged from 5 to 55; a higher score indicated more substantial confidence toward oral care for the elderly. Cronbach's alpha was 0.87 for this scale.

2.4.4 Intention to elderly oral care behaviors

Twelve items were used to evaluate the intention to elderly oral care behavior for elderly. Students indicated their goals of adding new behaviors or modifying existing behaviors of oral care for the elderly. For example, 'I will take the initiative to assist disabled elderly to clean their dentures.' Each item was scored on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.4.5 Covariates

Age and gender were assessed at baseline for each student in this study.

2.5. Interventions

The VR-based training system (Pvix VR, EPED Inc.) equipped an optical portable wearable device that utilizes positioning motion recognition technology and a built-in virtual interactive software to assist in the self-training of future oral care personnel and health caregivers. Students are immersed in a 3D environment as soon as they put on the optical 3D glasses. The oral health interactive software stimulates diverse ability levels through the simulation of different actions. Students learn standard procedures of oral care through automatic assessment. In addition, the software customizes standard process courses and teaching plans in several fields.

The students in EG received VR-based training for elderly oral health care at 2-week (Time 2), 4-week (Time 3), and 6-week (Time 4) follow-ups. The learning module was divided into three sessions according to the physical condition (1) Mild disability, (2) Semi-disability, (3) Total disability and oral condition, (1) wearing dentures, (2) missing teeth of the elderly (Figure 2.). Students simulate the different physical and oral conditions of the elderly through virtual situations and provide suitable oral care methods. The whole training session took approximately two hours for each student; First, students were first given a short introduction to the VR system's use (10 minutes). Second, they were able to carry out oral care for the elderly while wearing VR goggles and using hand-controllers with the teaching and audio guides during the process (90 minutes), and an evaluation was taken after the intervention (20 minutes).

The students in CG do not receive any of the interventions. However, the same VR-based curriculum of oral health care on dependency elderly were provided at the end of the study.

2.6. Data Collection

The students in both groups self-completed a baseline questionnaire after the allocation. The post-test was collected immediately after each intervention, and the satisfaction survey was collected at the end of the whole intervention in the experimental group. As for the control group, the post-test was collected at 2-week (Time 2), 4-week (Time 3), and 6-week (Time 4) follow-ups.

Statistical Analysis Plan

This study explored the variables' relationships using STATA version 13.1 (Stata Corp LP, College Station, Texas, USA). Percentage, Fisher's exact test, and Wilcoxon rank-sum test were used to compare the VRG and CG demographic variables. Wilcoxon rank-sum test compares the difference of oral care-related knowledge, Attitude, self-efficacy, and intention within groups. Linear regression in generalized estimating equations (GEE) compares the difference of oral care-related knowledge, attitude, self-efficacy, and intention between groups. The effect size (Cohen's d) of continuous variables were calculated from the mean difference between baseline and the follow-ups between the VRG and CG. An effect of 0.20 is small, 0.50 is medium, and 0.80 is large[16].

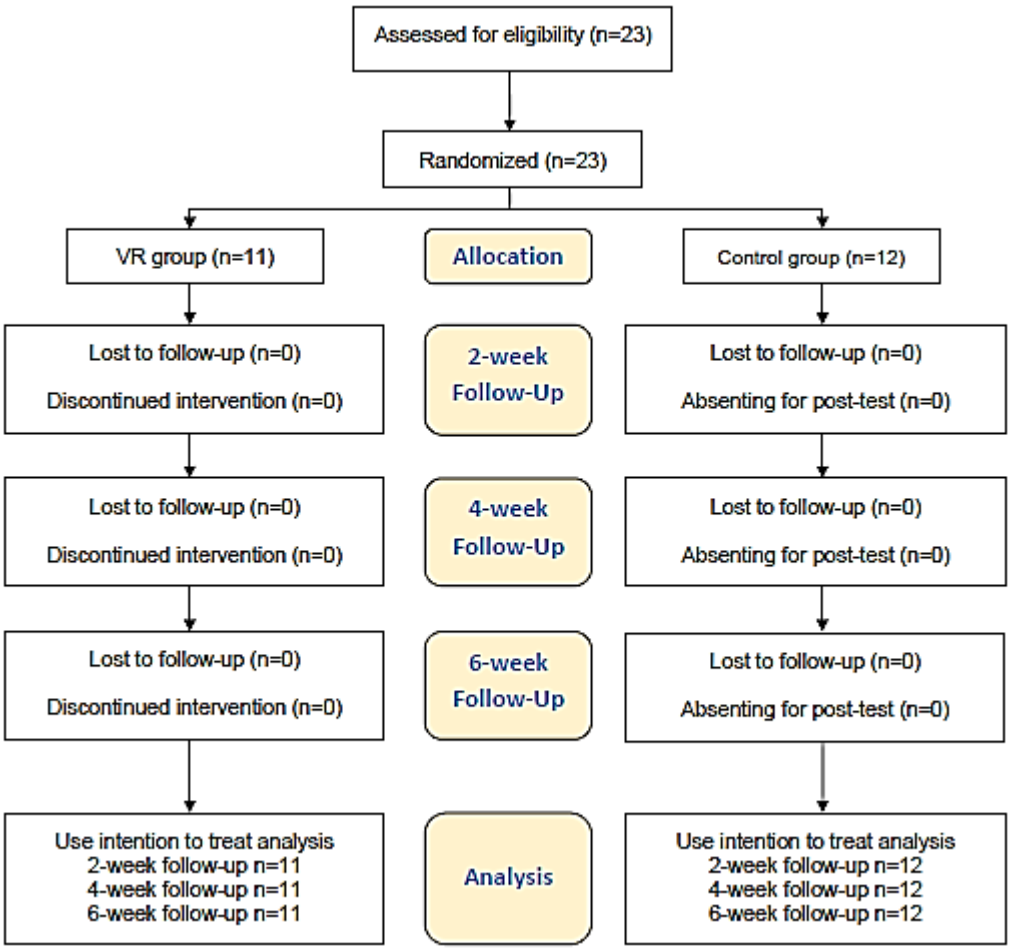

Figure 1. CONSORT flow diagram