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THE EFFECTS OF VIRTUAL REALITY SIMULATION USE ON NURSING STUDENTS DURING COVID-19: A SYSTEMATIC REVIEW

SANAL GERÇEKLIK SIMÜLASYON KULLANIMININ COVID-19 SÜRECINDE HEMŞIRELIK ÖĞRENCILERINE ETKISI: SISTEMATIK DERLEME

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ABSTRACT

Objective: This study was conducted to evaluate the effects of the use of virtual reality simulation on the education of nursing students during the Coronavirus-2019 (COVID-19) pandemic.

Methods: This systematic review scanned studies published in Pubmed, Cochrane and Ovid databases between November 2019 and September 2022 (last search date 16 September 2022) using the keywords "virtual reality" and "nursing education" or "nurse and education" and "COVID-19" and their combinations. The content of Medical subject headings (MeSH) was used to create keywords. Critical Appraisal Tools recommended by the Joanna Briggs Institute were used to assess the quality of the studies. Five studies out of 1648 studies scanned were included in this study.

Results: The sample in these studies, all conducted in a quasi-experimental design, ranged from 50 to 192. In the studies reviewed, the groups using virtual reality simulation had higher self-efficacy, perception, knowledge, learning motivation, problem-solving skills, self-confidence, learning satisfaction and practical performance than other groups.

Conclusion: The results indicated that virtual reality simulation could be used effectively in student nurse education during the COVID-19 pandemic.

Keywords: COVID-19, Nursing Education, Simulation, Virtual Reality.

ÖZET

Amaç: Bu araştırma Koronavirüs-2019 (COVID-19) salgın sürecinde sanal gerçeklik simülasyon kullanımının hemşirelik öğrencilerinin eğitimindeki etkilerini değerlendirmek amacıyla yapıldı.

Gereç ve Yöntem: Sistematik inceleme, Pubmed, Cochrane, Ovid ve Ebsco, Google Scholar and Web of Science veri tabanlarında Mart 2020- Eylül 2022 yılları arasında yayınlanan (son tarama tarihi 16 Eylül 2022) çalışmalar "virtual reality*" AND "nursing educatıon*" OR "(nurse and education)" AND "COVID-19*" anahtar kelimeler kullanılarak tarama yapıldı. Anahtar kelimeler için Medical Subjects Headings içeriğinden yararlanıldı. Joanna Briggs Enstitüsü tarafından önerilen Kritik Değerlendirme Araçları kullanıldı. Toplam 1648 çalışmadan beş çalışma araştırmaya dahil edildi.

Bulgular: Dahil edilen çalışmaların beşinin de yarı deneysel tasarımda olduğu, örneklem grubunun 50-192 arasında değiştiği belirlendi. İncelenen çalışmalarda sanal gerçeklik kullanan grupda öz yeterlilik, algı, bilgi, öğrenme motivasyonu, problem çözme yeteneği, kendine güven, öğrenme doyumu ve uygulama performansının daha yüksek olduğu belirlendi.

Sonuç: Elde edilen sonuçlar sanal gerçeklik simülasyonunun COVID-19 salgın sürecinde öğrenci hemşire eğitiminde etkin bir şekilde kullanılabildiğini göstermektedir.

Anahtar Kelimeler: COVID-19, Hemşirelik Eğitimi, Sanal Gerçeklik, Simülasyon.

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INTRODUCTION

The coronavirus-2019 (COVID-19) pandemic has had a critical impact on vocational training practices that include theoretical education, clinical practice, and laboratory courses. Due to the restrictions during the pandemic, the transition to online education happened very quickly (Cook and Camp-Spivey, 2022; Tabatabai, 2020). In this process, technology-supported education methods were used to develop and improve the integration of theory and clinical practice. There has been an increase in the need for virtual simulation-based training methods, which is one of the technology-supported training methods that support the development of clinical practice (Fealy et al., 2019; Zackoff et al., 2020).

In the literature, education based on virtual simulation has been noted to make the transition between theory and clinical practice easier for students, develop communication and technical skill acquisition, improve patient safety, standardize curricula and teaching content and provide clinical decision-making experience (Choi et al., 2022; Jadmiko et al., 2022; Plotzky et al., 2021). The fact that students would work in an environment that is risky for infectious diseases increases their anxiety (Zhang et al., 2022). It was reported in the literature that students' awareness can be increased and their anxiety can be reduced by developing their practical skills with virtual simulation methods (Jadmiko et al., 2022; Zhang et al., 2022).

Virtual reality (VR) simulation, which is one of the simulation methods, is widely used in the teaching of healthcare-related practices (Jallad and Işık, 2022; Karabacak and Uğur, 2019). Virtual reality simulation is a high-level computer-based technology-assisted teaching method that provides an auditory and visual learning experience in which objects or environments are imitated in the virtual environment and at the same time additional tools such as special technological glasses or headphones are used to enhance natural reality (Karabacak and Ugur, 2019; Mendez et al, 2020). Virtual reality simulation is noted in the literature as not only useful for education but also for preventing occupational accidents and providing occupational safety measures (Zhang et al., 2022). With the pandemic, the use of virtual reality simulation has been proven to be an effective tool in clinical practice education of nursing students in academic and professional environments (Jallad and Işık, 2022; Schuelke et al., 2019; Tabatabai, 2020).

The COVID-19 pandemic was an extraordinary situation all over the world, and as face-to-face education was suspended, the need for the use of virtual reality simulation in clinical practice in nursing, which requires clinical skills, has increased. In our study, we aimed to determine to what extent the use of VR, one of the technology-supported learning methods, is effective in nursing students in this extraordinary situation.

MATERIALS AND METHODS

This systematic review was conducted using the “Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) 2020 Statement” guideline (Page et al., 2021).

The Literature Review Process

Before starting the study, a pilot study was conducted and a scanning strategy was determined. The keywords of the articles reached through the pilot study were also included and the scanning was started. The literature review process of this study was carried out to cover the studies between March 2020 and September 2022 (the last date of scanning was September 16, 2022). Only full-text articles published in scientific journals were scanned. We conducted hand searching and found no further studies. Pubmed, Cochrane, Ovid, Ebsco, Google Scholar and Web of Science databases were used to collect the data. The content of Medical Subjects Headings (MeSH) was used to create keywords. The keywords “virtual reality” and “nursing education” or “nurse and education” and “COVID-19” and their combination were used for the scanning of the studies. The PRISMA 2020 flowchart showing how five studies includedin this systematic review from a total of 1648 studies have been reached is shown in Figure 1.

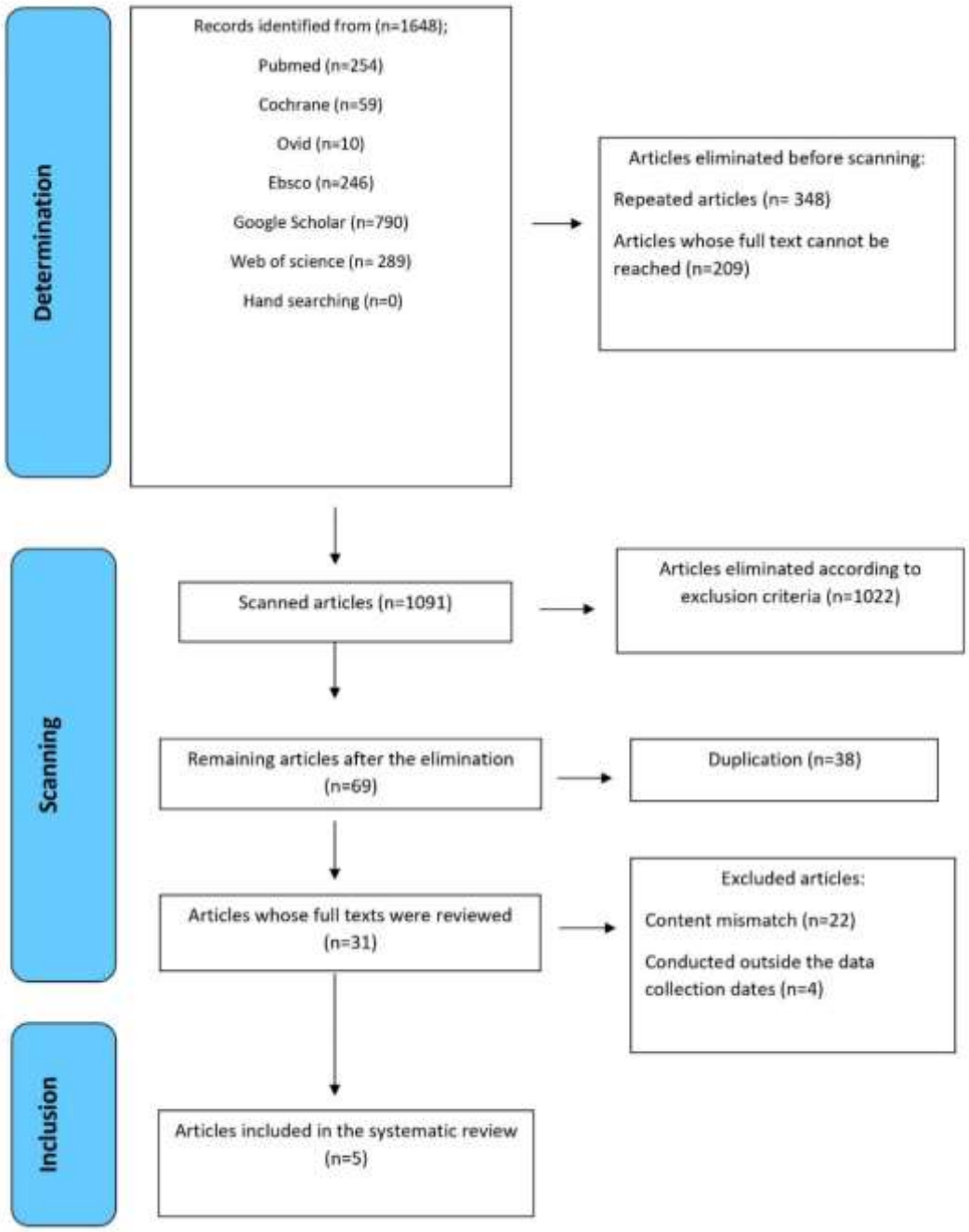

Figure 1. PRISMA 2020 flow diagram.

Inclusion Criteria

There was no language restriction in the selection of studies suitable for this systematic review. Studies which were

- Conducted on nursing students,
- Published in a national/international peer-reviewed journal,
- With a data collection date on or after March 11, 2020, which was the date COVID-19 was declared a pandemic.
- With their full text accessible, were included.
- Any reviews, case studies and theses were excluded from the study.
- This systematic review was conducted based on the PICO (Population-Intervention-Comparison-Outcome) method. The PICO items were as follows;
- Population: Nursing students
- Intervention: Virtual reality simulation method

- Comparison: Traditional methods
- Outcome: Effects on nursing students

Selection of the Studies

Based on the inclusion criteria, the titles and abstracts were reviewed by two researchers (YII/DHE) and the full-text selections were made independently. When there was any contradiction in the selection of articles to be included, this was resolved through discussion between the researchers. Reference lists of eligible articles were also reviewed.

Data Extraction

The data were obtained with the data extraction tool developed by the researchers in the Microsoft Excel program. This tool included data on the name of the authors, publication years, purpose, methods used in the study, and the Joanna Briggs Institute (JBI) quality assessment score (Table 1). This procedure was performed independently by two researchers. In cases where there were different data, the relevant study was checked again and the correct data was extracted.

Table 1. Characteristics of includedstudies.

Author Name and Year of Publication	The design and sample size of the study	Purpose	Characteristics of the participants and the conclusions of the study	JBI Critical Appraisal Quality Score
Yang and Oh (2022)	A quasi-experimental, pre-test-post-test design was used. Sample size n= 83 Virtual reality (VR) group (n=29), Simulation group (n=28), Control group (n=23)	An investigation of the effects of a neonatal resuscitation gamification program using immersive virtual reality based on Keller's ARCS model (neonatal resuscitation nursing knowledge, problem-solving and clinical reasoning skills, self-confidence in practical performance, anxiety level, and learning motivation).	Pre-graduate nursing students were included. Participants were n=83 female and n=14 male. The neonatal resuscitation gamification program using immersive virtual reality was found to be effective in increasing the general participant characteristics, neonatal resuscitation nursing knowledge, problem-solving and clinical reasoning skills, self-confidence and learning motivation of nursing students participating in the trial application process.	8/9
Jeong et al. (2022)	A quasi-experimental, pre-test-post-test design was used. Sample size (n=65). It consists of the intervention group (n=32) and the control group (n=33	Designing and use of a simulation program that applies the COVID-19 scenario to evaluate the effectiveness of a virtual environment in nursing students was aimed	Year 4 students of the school of nursing participated in the study. Participants were 11(16.9%) males and 54 (83.1%) were females. Participants' knowledge about infectious diseases in the respiratory system, self-efficacy, clinical reasoning ability and learning satisfaction were evaluated. High learning satisfaction was achieved in the intervention group. Self-efficacy and clinical reasoning were statistically significant	8/9
Kang et al. (2020)	The study was a preliminary and quasi-experimental study.	It aimed to examine the learning effects of Virtual Reality Simulation (vSim)	This study was conducted in three nursing schools located in different cities in South Korea. A total of 154 (80.2%) of the participants	9/9

	Sample size (n=192). In this study, three different teaching methods, Virtual Reality Simulation (vSim) (n=54), High Validity simulation (HFS) (n= 69), and a combination of vSim and HFS (n=69), were compared.	by comparing three different nursing care training methods for asthmatic children.	were female and their age was between 20 and 30. The group using vSim with HFS was determined to have the highest scores in knowledge, confidence in practice, and performance than groups using vSim or HFS alone. Simulation applications using vSim together with HFS can be an effective educational method for nursing students	
Yu and Yang (2022)	It is a quasi-experimental study based on a pre-test-post-test design. n=50 participants were included in the study. One intervention group (n=25) and a control group (n=25) were included in the VRICS program.	It was aimed to develop a virtual reality infection control simulation (VRICS) program for putting on and removing Personal Protective Equipment (PPE) and respiratory care for pediatric patients admitted to the isolation unit due to COVID-19 and determine the effects of this program on the PPE knowledge of nursing students taking pediatric courses.	Year 3 and 4 nursing students were included in the study. 45 (90.0%) of the participants were female and 5 (10.0%) were male. The general characteristics of the participants included age, gender, previous term grades and their VR experience. Compared to the control group, the intervention group showed more improvement in PPE knowledge, self-efficacy performance and infection control performance. The VR simulation training program involving pediatric COVID-19 patients effectively combined skills training and theoretical knowledge. It also developed respiratory care skills, preparedness for infectious diseases and problem-solving skills. Therefore, VR can be used in the education of nurses to more effectively respond to public health situations involving infectious diseases, including the COVID-19 pandemic.	8/9
Liu and Butzlaff (2021)	A quasi-experimental, pre-test-post-test design was used. **Participants in the study (n=50).** The traditional classroom environment (n=25) student group and the online classroom environment (n=25) student group formed the study groups.	This study aimed to examine the effects of incorporating a virtual reality activity into traditional and online classroom settings to improve the education of nursing students.	**Undergraduate nursing students** participated in the study. 74% of the participants were female, 24% were male, and 2% did not specify their gender. Nursing students successfully conducted a tour showing how to identify infectious zones in a hospital room setting via a virtual reality activity. Designing a significant virtual reality activity was concluded to have a positive effect on the student learning experience. A carefully created activity can improve students' learning outside of the hospital room.	8/9

Assessment of the Methodological Quality

The qualitative assessment of studies was carried out using nine-item critical evaluation checklists developed by JBI for quasi-experimental studies (Critical Appraisal Tools, 2022). The questions in this checklist are answered with the options "yes, no, unclear, and not applicable". A "quality score" was given to the assessment results for each study included in this systematic review. The quality assessment was carried out independently by two researchers, and if there were any differences in their answers, a discussion was held on these differences in order to reach a consensus.

RESULTS

Scan Results

As a result of the screening process, five studies that met the inclusion criteria were included in this systematic review. While all five studies were conducted in a quasi-experimental design, one of them was published in 2020, two were in 2021 and the other two were in 2022 and the sample group of the studies ranged from 50 to 192.

The Results of the Methodological Quality Assessment

The highest score given to these five quasi-experimental studies included in this systematic review by two researchers after their assessments was nine and the lowest score was eight. The mean scores given by the researchers for each study are shown in Table 1.

Characteristics of the Studies Included In the Review

The first study among these studies included in this review was conducted by Yang and Oh (2022) with pre-graduate nursing students as a pre-test and post-test in a quasi-experimental design. A neonatal resuscitation gamification program was applied to the virtual reality group (n=29) using virtual reality based on Keller's ARCS model. The simulation group (n=28) was given courses on high-fidelity neonatal resuscitation simulations and the online neonatal resuscitation program. The control group (n=26) was given courses only about the online neonatal resuscitation program. Before the intervention, only online neonatal resuscitation program courses were taken. After the intervention, neonatal resuscitation knowledge and learning motivation were found to be significantly higher in virtual reality and simulation groups. Problem-solving skills and self-confidence were significantly higher in the virtual reality group compared to the simulation group. Anxiety was significantly lower in the simulation group compared to the virtual reality and control groups. In the study, in which neonatal resuscitation knowledge was used, the use of virtual reality was found to be effective in increasing problem-solving skills, self-confidence and learning motivation.

In the quasi-experimental study conducted by Jeong et al. (2022), the participants were year-4 undergraduate nursing students. While 44 of the participants were satisfied with the clinical practice, 21 of them were not. The study investigated the design and use of a simulation program that uses the COVID-19 scenario to evaluate the effectiveness of a virtual setting. Participants' knowledge about infectious diseases in the respiratory system, self-efficacy, clinical reasoning capacity and learning satisfaction were evaluated. Infectious respiratory diseases, self-efficacy and clinical reasoning showed statistically significant differences between the pretest and posttest in both groups. The intervention group showed significantly higher learning satisfaction. However, no difference was found between the groups in terms of knowledge, self-efficacy and clinical reasoning.

Kang et al. (2020) examined the learning effects of Virtual Reality Simulation (vSim) by comparing three different nursing care training methods for asthmatic children. In the study, groups with three different teaching methods, namely Virtual Reality Simulation (vSim), High Fidelity Simulation (HFS) and both vSim and HFS together, were compared. No significant difference was observed between the three groups in terms of knowledge levels. The group using vSim with high-fidelity simulation was determined to have the highest scores in knowledge, confidence in practice, and performance than groups using vSim or HFS alone. A significant difference was found between the three groups in the degree of total performance scores.

In their study, Yu and Yang (2022) aimed to develop a virtual reality infection control simulation (VRICS) program for putting on and removing Personal Protective Equipment (PPE) and

respiratory care for pediatric patients admitted to the isolation unit due to COVID-19 and determine the effects of this program on the PPE knowledge of year 3 and 4 nursing students taking pediatric courses. This quasi-experimental study, based on a controlled pretest-posttest design, was planned for the development of a VRICS program to compare PPE knowledge, infection control performance and self-efficacy among nursing students and to determine the level of satisfaction with the program. A total of 50 individuals participated in the study, including the intervention (n=25) and the control group (n=25). While 45 of the participants were female and 5 were male. The general characteristics of the participants include age, gender, previous term grades and their VR experience. When compared with the control group, the intervention group showed significantly greater improvement in PPE knowledge, infection control performance, and self-efficacy. Virtual reality (VR) simulation training program involving pediatric COVID-19 patients effectively combined skills training and advanced theoretical knowledge, respiratory care skills and infectious disease preparedness. Thus, the conclusion has been reached that VRICS can be used in the education of nurses and respond more effectively to public health situations involving infectious diseases, including the COVID-19 pandemic.

In their study, Liu and Butzlaff (2021) examined the effect of incorporating virtual reality (VR) into traditional and online classroom settings on students' perceptions and performances, in traditional and online classroom settings. The study was conducted with undergraduate nursing students (n=50). The comparison was performed between the traditional classroom group (n=25) and the online classroom group (n=25). While 74% of the participants were female, 24% were male, and 2% did not specify their gender. A demographic data form and an online three-point Likert-type questionnaire measuring the performance and perceptions of the participants were prepared by the researchers and the learning satisfaction of the students was measured. There was no significant difference between the traditional and online classroom groups in terms of demographic data. Virtual reality activity, on the other hand, evaluated their perceptions and performances in a seven-stage 90-minute training activity. Pre- and post-test results have shown that the results were positive. The difference in the perception and performance of virtual reality activity between the groups, traditional and online classroom settings, was statistically significant. The use of virtual reality after technology adaptation and orientation was concluded to be significant.

DISCUSSION

The methodological qualities of the studies included in the review were scored between nine and eight according to the JBI quality assessment criteria. Therefore, it is possible to say that the methodological quality scores of the studies were high. In the studies reviewed, self-efficacy, perception, knowledge, learning motivation, problem-solving skills, self-confidence, learning satisfaction and practical performance were prominent in the groups using virtual reality simulation.

In the literature, there have been positive results on the fact that the virtual reality method increases the learning of nursing students with patient care, clinical skills improvement, empathy, and positive attitudes towards patient and employee safety (Farra et al., 2018; Kim and Chun, 2022). Our study supports the literature findings with the result that the learning motivation and experience of the groups using virtual reality simulation increased. The simulation program developed by Hwang and Lee (2021), targeting infectious disease, supports the findings of our study by improving the problem-solving skills of nursing students by positively influencing disaster preparedness, competence and confidence. Studies revealed the positive contribution of virtual simulations to students' performance in practice (Stephen et al., 2022). In an experimental study with a virtual simulation method and standard education practices to observe the clinical situation, the results of patient-nurse interaction indicated that there were no differences in the nursing students' understanding levels when compared to standard education (Stuart et al., 2021). In another experimental study, using virtual simulation has been reported to have a more important impact than theoretical and clinical training in improving the knowledge and confidence levels of nursing students to increase their clinical skills. It has been strongly recommended that virtual simulation is an effective educational approach for clinical training, especially during the COVID-19 pandemic (Tawalbeh, 2020). The literature findings support our study in these aspects.

In the literature, high-fidelity virtual reality simulation was noted to be effective in increasing the clinical experience (Farra et al., 2018). Virtual simulation applications are cost-saving and an

important innovative education and training method in the use of digital technologies in learning (Arrogante et al., 2021). In another study conducted in a quasi-experimental design, virtual reality simulation and immersive virtual reality simulation were compared in nursing students. In the study, virtual reality simulation was determined to be effective in increasing cognitive learning and learning performance, however, there was no difference when compared with each other (Smith et al., 2018). In our study, virtual reality simulation is seen to support the results for increasing learning motivation, satisfaction and practical performance.

In a systematic review carried out to evaluate the effectiveness of virtual reality simulation on the acquisition of clinical skills in nursing education and clinical performance, self-confidence, satisfaction and anxiety levels, virtual reality simulation has been reported to provide a learning strategy for nursing students to increase self-confidence, self-efficacy and satisfaction, and reduce anxiety levels (Jallad and Işık, 2022). It can be seen in our study that results supporting self-efficacy, knowledge acquisition, learning motivation, problem-solving skills, self-confidence, learning satisfaction and application performance have been achieved. Virtual reality has a lot to offer to the nursing field both in educational and in practical settings. Another study supports the fact that clinical practices can be carried out in a technology-supported manner by increasing interpersonal relationships and empathy (Dean et al., 2020).

CONCLUSION

The results revealed that VR simulation can be used effectively in student nurse education to improve professional practice by visualizing complex and extraordinary situations in technological environments and to improve students' problem-solving abilities.

We recommend the use of virtual reality simulation in the education of nursing students as it facilitates education and transition to practice in global pandemics such as COVID-19.

Conflict of interest

None.

Author Contributions

Plan anddesing: YİI, DHE FEA; Data collection: YİI, DHE; Analysis andcomments: YİI, DHE, FEA; Reviewandcheck: YİI, DHE, FEA; Writing: YİI, DHE, FEA.

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