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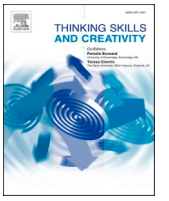

Effect of different simulation methods in nursing education on critical thinking dispositions and self-efficacy levels of students

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ABSTRACT

Background: Different simulation strategies are used to improving to critical thinking and self-efficacy skills, but evidence is limited about which provides better outcomes.
Aim: The aim of this study was to compare the effect of different simulation methods on the self-efficacy and critical thinking skills of students during pain management.
Methods: This was an experimental study. The students were divided randomly into an experimental (High fidelity = 23, Standardized Patient = 23) experiencing simulation and control groups (Control = 25) having traditional teaching program. All students were complete the study instruments pretest and posttest.
Results: There was no significant difference found between the groups for critical thinking disposition, self-efficacy, simulation performance, and knowledge level ($p > .05$). The self-efficacy post-test scores of the students in the control group were lower than the pre-test scores ($Z = -2.291$, $p = .022$). A moderate correlation was found between critical thinking and self-efficacy post-test scores, respectively of all groups ($p < .001$).
Conclusion: In this study, no differences in outcomes were identified between the simulation methods and traditional teaching methods. Future research should compare the effects repetitive of simulation methods in a larger sample.

1. Introduction

The healthcare system is becoming more complicated day by day with the continuous change in expectations and needs ins society, the rapid advancement of knowledge and technology, and the increasing importance of quality, safety, evidence-based practices, and individualized/person-centered care (Chan, 2013; Kim et al., 2017). In this complicated healthcare environment, nursing students have highly limited experience concerning professional decisions and practices (Hur & Park, 2012). However, it is vitally important for nursing students to accurately and effectively transfer knowledge into practice (Colin-Appling and Giuliano, 2017). For this reason, national and international nursing organizations consider clinical decision-making, problem-solving, critical thinking, and self-efficacy as the basic elements of nursing practice. Moreover, these organizations worldwide qualify critical thinking as an essential skill for the nursing profession (NLN, 2005; AACN, 2008; HUÇEP, 2014; World Economic Forum, 2020).

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1.1. Literature review

The increasing importance of quality and safety in healthcare environments, excessive number of students, and differences in professional decisions and practices of healthcare professionals have caused nursing students to gain limited levels of knowledge and skills during their clinical education (Nevin et al., 2014; Shin et al., 2015). For this reason, there is a need to use teaching strategies that promote the skills of analysis and synthesis to ensure the advancement of professional knowledge and skills among nursing students. Nevertheless, today's trainer-centered education system does not give students the opportunities to either question or use the knowledge they have gained or generate new knowledge. It has been stated that nursing students in Turkey have low to moderate levels of critical thinking skills (Akça & Taşçı (2009) Karadağlı, 2016). Additionally, a variety of research underlined that the critical thinking skills of students would evolve only with an improvement in thinking processes (Kanbay et al., 2013). It is becoming widely accepted that it is possible to improve students' critical thinking skills through the integration of planned and innovative learning strategies into educational programs, rather than adhering to short-term learning experiences (Behar -Horenstein & Niu, 2011; Chan, 2013; Goodstone et al., 2013; Hall, 2014; Şendir & Doğan, 2015; Kim et al., 2017; Liu & Pasztor, 2022). On the other hand; It is stated that gender, age, class, academic achievement, education level of parents, socio-economic status and education in private or public schools may have an effect on the improvement of critical thinking of students (Liu & Pasztor, 2022).

Besides being useful in increasing self-confidence and motivation, self-efficacy is also effective for students to become able to cope with negative situations and challenges while providing health care and putting knowledge into practice (Bandura, 1999). A study showed that there is a positive correlation between self-efficacy and academic performance of students (Pike & O'Donnel, 2010). For this reason, nursing students need effective learning strategies which ensure that the students can communicate with challenging and sensitive groups they encounter in clinical practice and increase their levels of self-efficacy.

Traditional teaching strategies, unstructured curricula, and clinical practices without standardization remain limited in developing critical thinking skills and self-efficacy levels of students. Currently, with the common use of simulation-based learning strategies in medical education, these limitations have started to fade away (Frost & Reid-Searl, 2017; Shin et al., 2015). High-fidelity simulators (HFS) which provide a 'close to reality' interaction ensure that students gain experience in making professional decisions and practices (Flude et al., 2012; Thideman & Söderhamn, 2013). Besides, a study emphasized that the use of standardized patients (SP) provides students with clinical experience close to reality and reinforces conceptual knowledge, improving the skills of critical thinking and decision-making, and psychomotor skills. Also, it supports individual learning and provides high satisfaction for learning (Oh et al., 2015; Şendir & Doğan, 2015; Kim et al., 2017).

In the literature, some studies separately evaluated the effect of different simulation methods on the critical thinking and self-

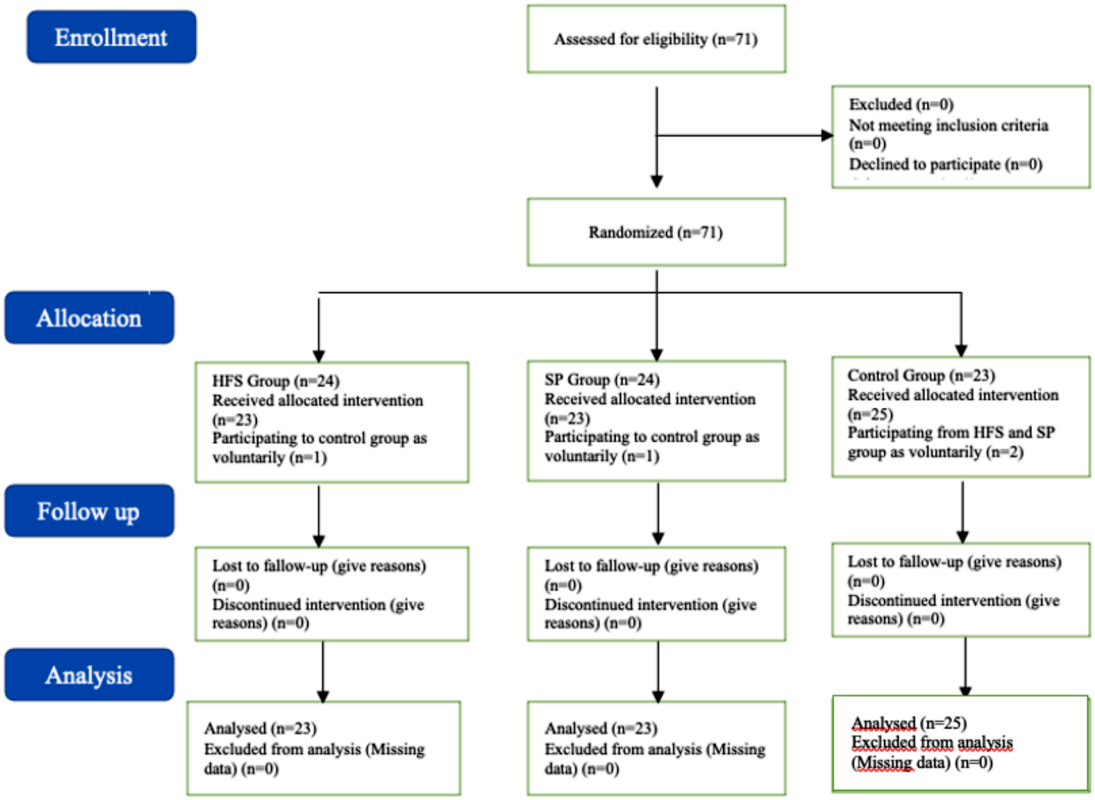

Fig. 1. CONSORT flow diagram.

efficacy of nursing students (Cardoza & Hood, 2012; Hall, 2014; Park et al., 2017; Shim et al., 2017; Shin et al., 2015; Wilson, 2014). The results of these studies show that simulation-based learning is effective in developing the students' skills of critical thinking, self-efficacy, decision-making, and problem-solving. However, no study was found in the literature to answer the question, "Which simulation method is more effective in developing critical thinking and self-efficacy?"s

1.2. Purpose

Our study aimed to investigate the efficacy of different simulation methods in the improvement of self-efficacy levels and critical thinking skills of students.

1.3. Hypotheses of the study

H1: Nursing students receiving education with HFS will have better/greater critical thinking skills compared to those receiving education with SP.

H2: Nursing students receiving education with HFS will have higher self-efficacy levels compared to those receiving education with SP.

2. Method

2.1. Study design

This study was an experimental study conducted with the pretest-posttest control group designs

2.2. Participants

The population for the study was comprised of 71 students attending their fourth semester of undergraduate nursing education at a university in Istanbul, Turkey. In the data collection process, each student was given an identification number to ensure consistency in repeated student assessments. Using the simple random sampling method, students were assigned to three groups: HFS ($n = 23$), SP ($n = 23$), and control ($n = 25$) (Fig. 1). The sample size was determined to have 83% power with a 5% error and 40% effect size as a result of power analysis (G Power 3.1.12 program).

2.3. Study tools

The California Critical Thinking Disposition Inventory (CCTDI), (2003 Turkish version) was used to determine the change in critical thinking of students. The scale was developed by Facione et al. (1994) and Turkish validity and reliability studies were performed by Kökdemir (2003). The scale consists of 51 items and 6 subscales with a Cronbach alpha internal consistency coefficient of 0.88. In this study, the Cronbach alpha internal consistency coefficient was found to be 0.84 for the pre-test and 0.89 for the post-test.

The Self-Efficacy Scale(SES), was used to determine the self-efficacy levels of students. The scale was developed by Sherer et al. (1982) and Turkish validity and reliability studies were performed by Gözüm & Aksayan (1999). The scale contains 23 items and 4 subscales with a Cronbach alpha internal consistency coefficient of 0.81 and test-retest reliability of 0.92. In this study, the Cronbach alpha internal consistency coefficient was 0.80 for the pre-test and 0.88 for the post-test.

Knowledge Assessment Form (KAF) was used to determine the change in knowledge levels of students about postoperative pain management. This form includes 20 multiple-choice questions prepared by the researchers in the light of literature (ASPMN, 2010; ANZCA, 2013; NIC, 2013) as well as the opinions of subject matter experts. The score students could obtain from the test ranges from 0 to 100 points.

Objective Structured Clinical Evaluation (OSCE) was created according to relevant guidelines (ANZCA, 2013; ASPMN, 2010; NIC, 2013) and expert opinions. It was used to determine the simulation performance. This tool consists of 35 items in 5 subdimensions: communication (4 items), diagnosis of pain (10 items), monitoring of physiological and psychological symptoms of pain (7 items), management of pharmacological and non-pharmacological of pain (10 items), and assessment of pain management (4 items). Each item is scored from 0 to 2 (0 = inadequate, 1 = needs development, and 2 = adequate) according to the performance of the student. The total score a student can get from this evaluation varies from 0 to 70 points.

A simulation Assessment Survey was conducted to assess the perspective and satisfaction of students after the simulation experience. This test was created by the researcher of this study. In the first part of the survey, students assessed the efficacy of the simulation and reviewed their performance. In the second part, students rated the effect of simulation experience on clinical practice from 1 to 10 points. The simulation assessment survey was evaluated by experts in terms of content, measurement-assessment, clarity, and understandability.

2.4. Study procedure

The research phases are presented under the headings of preparation and implementation.

2.5. Preparation

Theoretical courses: As the students were expected to show their cognitive, behavioral, and psychomotor skills during the simulation, a scenario which was based upon 'postoperative pain management' was prepared. The course content was prepared in the light of literature and by receiving opinions from experts in the fields of nursing, medicine, and education. The simulation design was created following INACSL standards of best practices in the postoperative pain management scenario.

A preliminary study of the simulation was performed with 10 students who completed the surgical nursing course in the previous semester. The students were randomly assigned to the HFS and SP groups, and the phases specified in Table 1 were followed. Pre-test/post-test tools and simulation design were optimized according to the results of the present study.

During simulation experiences, two independent observers (medical-surgical nursing experts) assessed the simulation performance of students. The role of a standardized patient was acted out by a professional actress. To enhance the realism of the roleplay and provide effective feedback to students, the researchers and an orthopedic nurse helped the actress get ready for their role. For HFS, we used a Computerized Patient Simulator (Laerdal SIMMAN 3 G).

2.6. Intervention

Table 1 shows the stages followed during the implementation of the study.

Pre-simulation: The theoretical course was communicated to students by the researchers in 4 sessions using different teaching methods. After the courses, students were assigned to the groups of HFS ($n = 23$), SP ($n = 23$), and control ($n = 25$). Pre-test data were collected with the CCTDI, SES, and KAF.

Simulation experiences: In the pre-briefing session, the researchers informed the students about the environment, method, and scenario of the simulation. Later, students were given the 'student simulation guide' and requested to prepare for the scenario. Students were taken into the simulation environment one by one to prevent interaction and ensure an objective assessment of simulation performance. Two independent observers assessed the student's simulation performance with the OSCE. After simulations were completed, the researchers completed the session by debriefing with the Plus-Delta method. In the debriefing session, audio recordings were taken with the permission of the students.

Post-simulation: Students assessed the simulation experience with the 'simulation evaluation survey'. The post-test data were collected from the students at the end of the semester.

2.7. Analysis

Data obtained in the study were analyzed using the SPSS 21.0 (Statistical Package for Social Science for Windows) licensed to the university in the computer environment. For comparison of independent groups, the Mann-Whitney U test and the Kruskal Wallis test were used, while for comparison of dependent groups, the Wilcoxon signed-rank test was used. The intraclass correlation coefficient was calculated to determine the compatibility between independent observers. To determine the correlation between scale points, Spearman's rank-order correlation analysis was used. Data obtained from audio recordings during the debriefing were transcribed and analyzed thematically using the descriptive phenomenology approach.

2.8. Ethical considerations

Every student who accepted to participate in the research received information about the study's aim, duration, and what was expected from the study and provided written consent. Ethical permission was granted from the Ethics Committee of a university in Istanbul (Decision Number: 10,840,098–46). To ensure equal opportunities in education, after collecting the post-test data in the

Table 1
Intervention protocol and procedure.

Theoretical Courses on "Post-Operative Pain Management"(4 H)		
Pre test **CCTDI, SES, KAF** (Before clinical practice)		
HFS Group	**SP Group**	**Control Group**
-Sharing training materials for preparation simulation -Prebriefing -HFS Simulation Experience with Pain Management Scenario -Debriefing -Continuing theoritical/clinical education in the curriculum	-Sharing training materials for preparation simulation -Prebriefing -SP Simulation Experience with Pain Management Scenario -Debriefing -Continuing theoritical/clinical education in the curriculum	-Continuing theoritical/clinical education in the curriculum
Post test **CCTDI, SES, KAF** (End of the Semester)		

study, the students in the control group were also provided with the opportunity to receive simulation-based learning using the standardized patient method in the same scenario as the study groups completed.

3. Results

The age average of students was 20.3 years (SD = 0.87). The majority of students were women (91.5%) and were determined to have a mean academic success score of 2.56 (SD = 0.31; min.:1,60, max.:3,22) at the end of the third semester. In terms of demographic characteristics, there was no significant difference between the groups ($p > .05$).

There was no significant difference between the groups regarding the pre-test and post-test scores related to critical thinking disposition, self-efficacy, and knowledge level ($p > .05$) (Table 2). In the HFS group, critical thinking disposition (Pre-test: 35.11; Post-test: 37.80) and self-efficacy level (Pre-test: 35.41; Post-test: 39.17) were determined to have increased. The rate of increase in the critical thinking disposition (Pre-test: 35.61; Post-test: 37.48) and self-efficacy level (Pre-test: 32.37; Post-test: 32.80) of the SP group was found to be lower. The critical thinking post-test score (Post-test: 32.98) of the control group was lower than their pre-test scores (Pre-test: 37.14). Additionally, in the control group, the post-test self-efficacy score (Pre-test: 39.88; Post-test: 34.50) was found to be significantly low ($z = -2.291$; $p = .022$) (Table 2).

There was no significant difference between the HFS and SP groups regarding their scores in simulation performance ($p > .05$) (Table 3). The intraclass correlation coefficient between independent observers evaluating simulation performance was calculated as 0.94.

In the post-test, there was a positive and moderately significant correlation between the critical thinking disposition and self-efficacy scores of the HFS ($r = 0.678$; $p < .001$), SP ($r = 0.732$; $p < .001$), and control groups ($r = 0.596$; $p = .002$). No significant correlation was found between the simulation performance, knowledge level, and academic success scores of the HFS and SP groups ($p > .05$) (Table 4).

There was no significant difference between the HFS and SP groups regarding the scores they rated for the impact of simulation on clinical practice and effectiveness of simulation ($p > .05$) (Table 3). As a result of a thematical analysis of the voice recordings during the debriefing, the themes that came to the forefront were "not being able to reflect knowledge in practice"', "anxiety resulting from taking direct responsibility for patient care", and "difficulty in decision making". Students expressed their opinions saying, for example, *"…I experienced problems related to making decisions when I came face-to-face with the patient, I feel inadequate in this matter", "…the patient's responses stressed me out", "…I was very excited. I didn't know what to do. I listed what I would do in my head earlier but I was paralyzed in the simulation environment"*.

4. Discussion

4.1. Results related to critical thinking disposition of students

The World Economic Forum (2020) lists competencies such as analytical and critical thinking, problem-solving, creativity, and leadership among the competencies that will be needed in 2025. Among these competencies, critical thinking is accepted as an important component that enables individuals to analyze nursing interventions and their potential results in terms of the nursing profession (Scheffer & Rubenfeld, 2000; Tajvidi, 2014). In order to improve critical thinking in nursing education, it is necessary to use different approaches such as problem-based learning, reflective essay, clinical laboratory together with theoretical education and simulation-based learning, and continuous education (Carvalho et al., 2017).

In this study, the effect of different simulation strategies was examined to improve the critical thinking skills of nursing students. As a result, although there was no significant difference, the critical thinking disposition was enhanced in the HFS and SP groups while it

Table 2
Changes over time in outcomes ($N = 71$).

		n	Pre test Mean Rank	Post test Mean Rank	z	p
Critical Thinking	HFS	23	35,11	37,80	−0,887	0,375
	SP	23	35,61	37,48	−0,030	0,970
	Control	25	37,14	32,98	−1501	0,133
	KW		0,126	0,830		
	p		0,939	0,660		
Self efficacy	HFS	23	35,41	39,17	−0,075	0,940
	SP	23	32,37	32,80	−1128	0,259
	Control	25	39,88	34,50	**−2291**	**0,022**
	KW		1617	1200		
	p		0,445	0,549		
Knowledge Levels	HFS	23	36,33	36,87	−1023	0,306
	SP	23	44,09	43,91	−1123	0,261
	Control	25	28,28	27,92	−0,979	0,327
	KW		7170	7364		
	p		0,028	0,025		

Table 3
Evaluations regarding the simulation experience ($N = 46$).

	n	HFS Mean Rank	SP Mean Rank	z	p
Simulation Performance (OSCE) (Sum of observers)	23	27,00	20,00	−1774	0,076
Effectiveness of simulation*	23	24,21	22,89	−0,315	0,753

Table 4
Relationships among study variables in the post test ($N = 71$).

	HFS r(p)	SP r(p)	Control r(p)
Critical Thinking / Self Efficacy	**0,678 (<0,001)**	**0,732 (<0,001)**	**0,596 (0,002)**
Simulation Performance (OSCE) / Knowledge Levels	0,108 (0,622)	−0,156 (0,479)	–
Academic Success / Simulation Performance	0,298 (0,167)	0,006 (0,979)	–

decreased in the control group. Similarly, Shin et al. (2015) showed that critical thinking skills did not increase significantly in the group experiencing simulation for the first time; however, there was an increase in the skills of critical thinking only after three or more experiences in the simulation environment. There are studies in the literature reporting similar results to Shin et al., i.e. simulation-based learning did not increase critical thinking skills (Ahn & Kim, 2015; Chung et al., 2016; Joo et al., 2015; Kang et al., 2020). In the light of these results, it may be interpreted that an increase in critical thinking skills may be observed more effectively with repeated simulation sessions.

Additionally, in this study, critical thinking disposition was determined to be higher in the HFS group, but no significant difference was observed. In the literature, there are not many studies that evaluated the effect of different simulation methods on critical thinking skills. The study by Ko & Kim (2014) did not report a significant difference between the SP and HFS groups in critical thinking skills. According to the findings obtained from the study, it was determined that a simulation experience did not make a significant difference in the improvement of critical thinking when compared to the traditional teaching program. However, to reach a clear conclusion, there is a need to evaluate the results of repeated simulation studies performed with larger sample groups.

4.2. Results related to self-efficacy levels of students

Nurse educators can encourage students to achieve a task with appropriate educational approaches. According to Pisanti et al. (2015), if students believe that they can perform a task, their effort to achieve that task will also positively affect their self-efficacy. Simulation-based learning allows students to learn without fear of making mistakes. In this study, although there was an increase in the self-efficacy levels of the HFS and SP groups after experience in the simulation environment, the most striking finding was that there was a significant decrease in the self-efficacy of the control group. According to Bandura (1994), feedback from people around individuals is important for improving self-efficacy. For this reason, continuous clinical practice after the simulation experience may have positively affected self-efficacy levels. However, further research is needed to test this assumption.

Despite the increase in self-efficacy levels after simulation, the lack of significant differences indicates the need for repeated simulation as it is the case in critical thinking. The results of Cardoza & Hood (2012) reported supporting evidence that the self-efficacy levels of participants increased significantly on the third and fourth measurements. Similarly, other studies investigating SP and HFS did not find a significant difference between the groups regarding the self-efficacy levels of students (Schroeder, 2019; Wilson, 2014).

According to the results of this study, the higher the critical thinking disposition of students became, the greater their self-efficacy levels enhanced. A study related to HFS by Park et al. (2017) identified a moderate and positive correlation between critical thinking levels and self-efficacy which supports the outcomes of our study. In short, both critical thinking and self-efficacy will increase increased with simulation experiences.

On the other hand, no difference was found between the simulation performances of the HFS and SP groups. Furthermore, no relationship was found between simulation performance, knowledge level, and academic achievement scores. In this study, students experienced simulation for the first time. For this reason, it is thought to be the reason why students had difficulty in transferring theoretical knowledge into practice. In a meta-analysis study in the literature, HFS was found to have a limited impact on learning outcomes (Sherwood & Fransis, 2018). Therefore, integrating simulation methodology into the education curriculum can make a significant difference in improving learning outcomes.

Simulation-based education is limitedly used in Turkey, and the students in our sample group had no experience with simulation. Also, the study by Mclean et al. (2019), found that students felt anxiety and stress during simulation experiences. Therefore, it should be considered that students' stress level during the first experience with simulation may have affected their performance. The opinions expressed by the students during the debriefing session support this assumption: *"I was very excited. I did not know what to do. I listed what I would do in my head, but I was paralyzed in the simulation environment" (HFS), "I felt like I'd started nursing and was performing implementations about pain for my first patient. The patient's nonverbal pain symptoms like moaning stressed me out. I was very nervous because until that day I had never undertaken such a responsibility" (SP).*

According to the students, the standardized patients' verbal and nonverbal responses to pain were the stressors. It may be

interpreted in the light of these findings that the students in this group may have more strongly had the feeling as if they had been taking the responsibility of a real patient. Such feelings may have also affected the simulation performance of the students, potentially causing students in the HFS group to have greater critical thinking and self-efficacy compared to the SP group. We believe that studies with larger sample groups and repeated simulations will reveal a more significant difference.

5. Limitations

The small sample group and its single-center design limit the generalization of the results of the study. The fact that the students did not have a simulation experience earlier and performed the tasks in the simulation environment themselves may have caused stress.

6. Conclusions

The results of the study show that simulations with HFS had a more positive effect in improving the critical thinking disposition and self-efficacy levels of students. This improvement may be more clear with a larger sample group and repeated simulations. At the same time, it would be beneficial to take precautions to reduce the anxiety level of the students during the simulation experience. The results of this study also confirmed the need to integrate student-centered educational methods in nursing education programs. These results indicate that well-structured educational programs that use either teaching method effectively promote critical thinking and self-efficacy of nursing students. This study will contribute to the limited literature investigating effective simulation modalities to improve critical thinking and self-efficacy and will guide future research.

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Authorship contribution statement

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CRediT authorship contribution statement

Pınar Doğan: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft. **Merdiye Şendir:** Conceptualization, Methodology, Investigation, Writing – review & editing.

Declaration of Competing Interest

The authors declare no conflict of interest.

Data Availability

: The data that has been used is confidential.

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