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Research article

Evaluation of the effectiveness of artificial intelligence assisted interactive screen-based simulation in breast self-examination: An innovative approach in nursing students

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ABSTRACT

Background: Breast self-examination is important in the early diagnosis of breast cancer. The use of traditional education methods is insufficient for student nurses to gain breast self-examination skills in nurse education. New and different education methods are needed to gain skills in nurse education.
Objective: The aim of this study was to evaluate the effectiveness of artificial intelligence-assisted screen-based simulations practice and standard patient simulation in teaching breast self-examination skills in nursing undergraduate students.
Design: This study was a comparative intervention trial.
Settings: This study was conducted at a university in XX, in XXX in the first semesters of the academic years 2022–2023.
Methods: This study enlisted 103 students enrolled in first year in a nursing department. Students were randomized into artificial intelligence-assisted screen-based simulations practice group ($n = 52$) and standard patient simulation group ($n = 51$). Data were collected using student description form, breast self-examination checklist, student satisfaction and self-confidence in learning scale, Spielberger's state and trait anxiety inventory.
Results: The highest score regarding the total score means of breast self-examination skills belonged to the standard patient simulation group, and the differences between the groups were found to be statistically significant ($p < 0.05$). Although the mean score of anxiety levels of the students' artificial intelligence-assisted screen-based simulations practice group was higher than the standard patient simulation ($p < 0.05$). The mean score of the students' satisfaction with the simulation was higher in artificial intelligence-assisted screen-based simulations practice group than the standard patient simulation group ($p < 0.05$).
Conclusions: The results of the research showed that the use of artificial intelligence-assisted simulation learning increased students' satisfaction, but at the same time students' anxiety increased. In addition, artificial intelligence-assisted simulation learning is not as effective as standard patient simulation learning in gaining breast self-examination skills.

1. Introduction

Breast cancer is the most common cancer in women. More than 1.15 million people are diagnosed with breast cancer each year (World Health Organization, 2019). In Turkey, the most common type of cancer among women is breast cancer, and it ranks eighth among the diseases that cause death (Kara and Keskinkılıç, 2021). Breast self-examination (BSE), clinical breast examination (CBE) and mammography are the main methods used in the early diagnosis of breast cancer. BSE is superior to other early screening methods because it is easy to perform, cost effective, protects privacy, does not involve invasive procedures, and does not take the woman's time (Husna et al., 2019). By teaching BSE in nurse education, the aim is to increase the knowledge level of students and to improve their psychomotor and communication skills. After gaining proficiency in breast self-examination, student nurses can provide training and counseling to women in clinical settings under the supervision of a clinical trainer and teach this skill by demonstrating. Nursing is focused-on person centred care, and is a comprehensive

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applied discipline that includes scientific knowledge (Deng, 2015). Clinical learning is the integration of theoretical and practical learning experiences (Phillips et al., 2017). However, hospitals prohibit students from providing nursing care directly without supervision to ensure patient safety and prevent medical accidents (Sim et al., 2021). A lack of a sense of belonging, a lack of self-motivation to learn, and a fear of making mistakes (Panda et al., 2021) impacts student learning. Instructors' negative behaviors and attitudes (Zhu et al., 2019), including failure to provide feedback (George et al., 2020) and an excessive number of students (Karaöz, 2013) makes it difficult for student to acquire all desired skills.

The use of virtual worlds in nurse education and clinical practice is becoming increasingly widespread due to technological developments with students more sensitive to technology (Shorey and Ng, 2021). Simulations are able to replicate aspects of the real world to support clinical practice. High-fidelity simulations and standardized patient simulation (SPS) have a demonstrable effect in improving students' performance skills and metacognition (Shin et al., 2019). SP is an effective strategy used in nurse education and provides several advantages including real-world learning experiences for students, enhancing prevention skills for clinicians, and decreasing any anxiety or stress they may experience while offering real patient care in clinical settings (Sarmasoglu et al., 2016; Zabar et al., 2010).

Artificial intelligence-assisted screen-based simulations have a key role in the education system to provide a more realistic experience for nursing students (Dante et al., 2020). The use of artificial intelligence supported screen-based simulations in nurse education can improve students' clinical reasoning skills (Dubovi, 2019) and contribute to the development of teamwork, decision-making, and communication skills (Peddle et al., 2020). The use of Artificial Intelligence Assisted Interactive Screen-Based Simulation (AI-AISBS) is limited with few studies in nurse education (Shorey et al., 2019; Sitterding et al., 2019). To our best knowledge there is no study in the literature comparing AI-AISBS and SPS to gain of the breast self-examination skills. For this reason, the aim of the study is to evaluate the effect of artificial intelligence supported interactive screen-based simulation and standard patient simulation on students' skills performance score, satisfaction, and anxiety in BSE education.

The following hypotheses were tested in this study:

H1. There is a difference in BSE skill performance score of students between SPS and AI-AISBS groups.

H2. There is a difference in satisfaction with simulation of students between SPS and AI-AISBS groups.

H3. There is a difference anxiety levels of students between SPS and AI-AISBS groups.

2. Methods

2.1. Study design and setting

In the first semesters of the 2022–2023 academic year an intervention and comparative study was conducted in the Nursing Department of the Faculty of Health Sciences of a state university in the north of XXXX.

2.2. Randomization and allocation

A list of nursing students enrolled in the first-year spring semester has been prepared. Assignments to Artificial Intelligence Simulation (AI-AISBS) and Standard Patient Simulation (SPS) groups were made by an independent researcher using the list computer program (random.org) at a ratio of 1/1. Students were randomly assigned to either an AI-AISBS group or a SPS group. While researchers and students were not blinded to group allocation, the biostatistician remained blinded. Group randomization was unstratified.

2.3. Sample/participants

The sample in this study was composed of first-year students in the department of nursing. First year students were selected because the BSE education to students occurs during this period and this is the time when they start their clinical practice. The sample inclusion criteria were a) not received any training on BSE, b) had no verbal or written communication problems, c) not being exchange students, and d) willing to provide written informed consent prior to participating in the study. G-power package version 3.1.9.2 was used for determining the sample size. Prior and post-hoc power analysis was both performed based on a fixed effect ANOVA test. Expected Cohens' f value for effect size was 0.4, which is considered a large effect size. For a 0.4 effect size with 0.05 types I error and 80% power minimum required, an estimated total sample size was 76. There were 110 students enrolled in the first-year nursing department during the relevant period. Six students did not agree to participate in the study. The most provided reasons were lack of time. One of the students were excluded from the study because they did not attend the theoretical training (Fig. 1). For this reason, the study was carried out with 103 students (AI- (AI-AISBS = 52, SPS = 51)) who met the inclusion criteria (Fig. 1).

2.4. Intervention

Researchers contacted students through their WhatsApp groups and invited them to participate in the research. Students were informed that their decision whether to participate in the research would not affect their grade point averages. Students who agreed to participate in the research were interviewed in the seminar hall of the faculty. Written consent was obtained by giving information about the research. BSE theoretical training nursing program was given to students for 1 h on the appropriate day and time. The training contents were created and sent for expert opinion, and the content validity was calculated in line with the opinions received (Table 1).

2.4.1. Artificial Intelligence Simulation (AI-AISBS) group

Students in this group participated in artificial intelligence supported interactive screen-based simulation practice. It was designed according to the BSE scenario, which was created before the artificial intelligence supported software program and was finalized by taking the opinions of the experts and the content validity was calculated in line with the opinions received (Table 2). AI-AISBS application is a software program compatible with computers, laptops, and smart phones, which can be entered via link and password. The AI-AISBS is a female avatar with the same scenario as the standard patient. AI avatar is a virtual character, powered by artificial intelligence, has features such as starting and ending communication. During the creation of the artificial intelligence, the BSE checklist answer key was uploaded. Artificial intelligence was used to analyze the information given by the students for each step and determined the average performance score of the students from there BSE skills. The performances of the students towards BSE were scored by artificial intelligence according to the BSE checklist algorithm.

Before the artificial intelligence practice, the students filled out the student description form, and the students were informed about the use of the application. A different username and password were created for each of the students to use the application. Access to the application with the given passwords is set to be only once. The problem was solved by sending a new password to the students who had access problems during the application phase. The computer lab was set up separately for each student. Practices of students have been recorded. AI-AISBS took an average of 20 min for each student. Right after the artificial intelligence application, students were asked to fill out the Student Satisfaction and Self-Confidence in Learning Scale and Spielberger's State and Trait Anxiety Inventory Scale. A 20-minute feedback session was given to the students, whose application was completed, by making them watch the simulation performance.

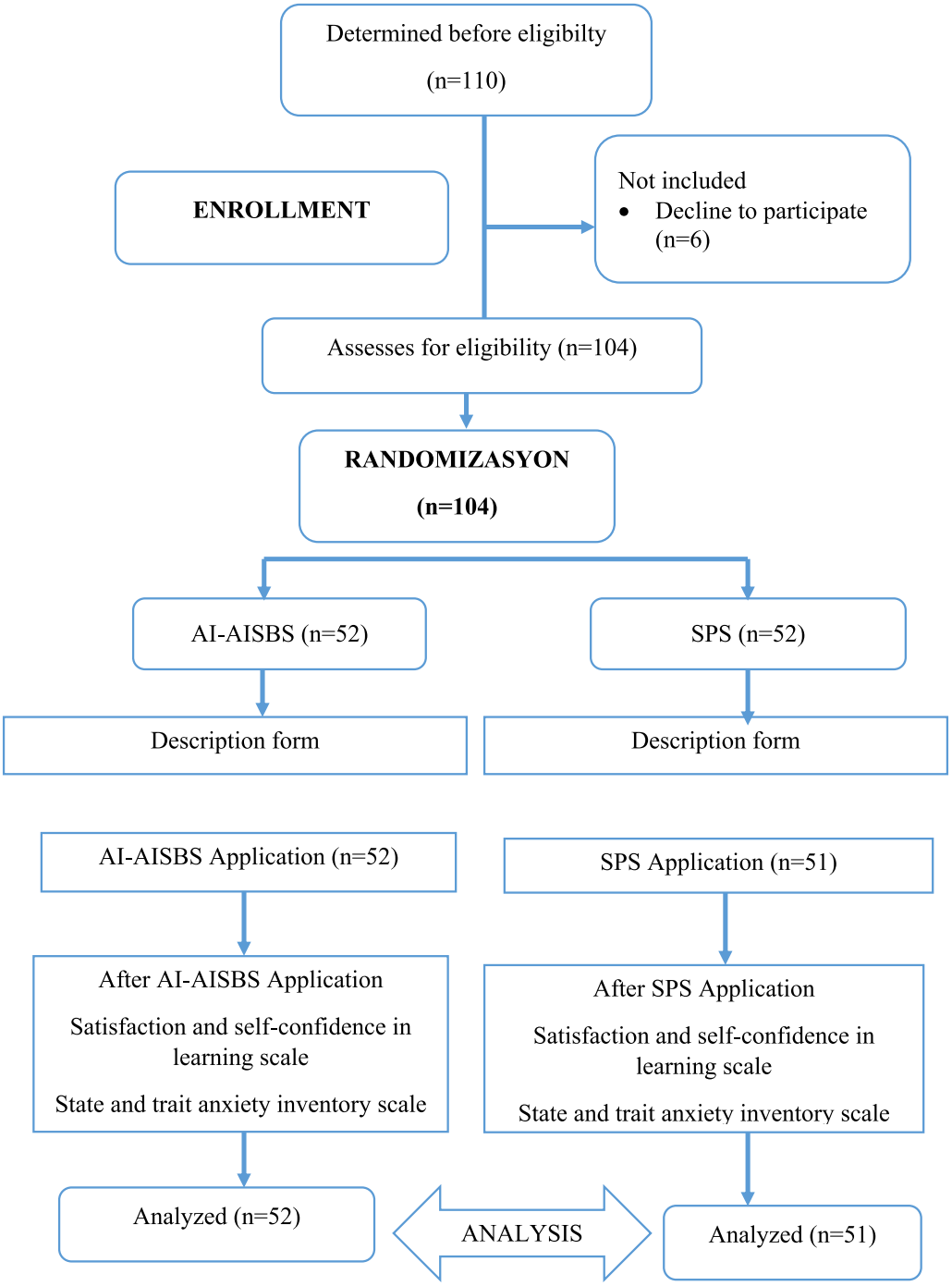

Fig. 1. Flow diagram.

2.4.2. Standard Patient Simulation (SPS) group

Students in this group participated in the standard patient simulation practice. Students were informed about the standard patient practice in the meeting room. The students were divided into 10 groups of five. Students participated in the simulation application one by one.

The standard patient was informed about the subject, the scenario was sent (Table 2), and the studying hours were adjusted according to the students. Students performed simulation practice on the specified day and time. Before the application, the students filled out the student description form. The standard patient practice included the same scenario and learning objectives as the (AI-AISBS). SPS was performed in a quiet room prepared for the outpatient setting. The simulation took about 15 min. The simulation practice was recorded and the performances of the students in the standard patient and the performance of student with BSE were scored by a single researcher based on the BSE checklist answer key and the student's total score was evaluated. Right after the standard patient simulation application, students were asked to fill out Student satisfaction and self-confidence in learning scale and Spielberger's state and trait anxiety inventory forms. A 20-minute feedback session was given to the students by watching the standard patient application recorded for each student.

2.5. Data collection tools

Study data were collected via the student description form, the BSE skill evaluation form, student satisfaction and self-confidence in

Table 1
Breastfeeding training programme.

Breastfeeding training programme	Content	Outcomes
• 1st day • Duration: 2 h	✓ Breast anatomy and lactation physiology ✓ Properties and benefits of breast milk ✓ Breastfeeding preparation and breastfeeding techniques	- Be able to tell the importance of breastfeeding - Be able to tell the breastfeeding techniques
• 2nd day • Duration: 2 h	✓ Effective breastfeeding ✓ Tips to show that breast milk is sufficient. ✓ Nutrition of the lactating woman	- To learn effective breastfeeding - To learn nutrition of the lactating woman
• 3rd· day • Duration: 2 h	✓ Factors that increase and decrease breast milk. ✓ Maternal mental health and breastfeeding ✓ Expressing and storing breast milk ✓ Nipple care	- To be able to tell factors that affecting breastfeeding - To be able to explain the relation between breastfeeding and mental health. - Be able to tell storing conditions of milk - Explain nipple care
Teaching Breastfeeding skill	Implementation of Breast self-exam on the model, dolls	To be able to apply breastfeeding on breast model
Teaching strategies	Lecture Power Point presentation Video demonstration Group discussion, reflection, and feedback	

Table 2
The scenario.

The simulated patient stated to the student nurse that he wanted to learn BSE and they wanted to get help in this regard. A 47-year-old, high school graduate and housewife, female patient who entered the menopause. She went through menopause last year. She has pain in her right breast after entering menopause. When he touched her breast with his hand, a stiffness came to his hand. When she checked again later, she couldn't feel the stiffness. There is a flattening on the nipple and an orange peel appearance on the breast. The patient has anxiety and anxiety about the situation and does not know what to do.

learning scale, Spielberger's state and trait anxiety inventory.

2.5.1. Student description form

This form consisted of 4 sociodemographic questions (age, sex, graduated high school, previous BSE training)

2.5.2. Breast self-examination checklist

The breast self-examination checklist was used to evaluate the psychomotor skills (Taşkın et al., 2011). The checklist was rated based on a five-point Likert scale (0 = applied none of the activities, 1 = applied less than half the activities; 2 = applied half the activities; 3 = applied more than half the activities; 4 = applied all the activities). The total scores of the students in the forms were calculated out of 100.

2.5.3. Student satisfaction and self-confidence in learning scale

The "Student Satisfaction and Self-Confidence in Learning Scale" was published by the National Nursing Association (Franklin et al., 2014), and adapted to Turkish by Karacay and Hatice (2017) in a nursing college. This scale consists of two sub-dimensions, "satisfaction with learning" and "self-confidence", in a five-point Likert-type scale, with a total of 13 items. There are five items in the Satisfaction with Learning sub-dimension, and eight items in the Self-Confidence sub-dimension. The highest score that can be obtained from the scale is 65 and the lowest score is 13 (Karacay and Hatice, 2017). The internal consistency coefficient of the overall scale is 0.90. The internal consistency coefficient of the overall scale was found 0.877 for this study.

2.5.4. Spielberger's state and trait anxiety scale

The State–Trait Anxiety Inventory (STAI) was developed by Spielberger (1970) and adapted for Turkish by Öner and LeCompte (1985). STAI consists of 40 items and includes two separate scales. The "Trait Anxiety Scale" was developed to identify how an individual felt in general. The reliability coefficient determined by the alpha correlation was between 0.83 and 0.87. The "State Anxiety Scale" is a scale that shows how an individual feels in a situation and in the particular conditions. The reliability coefficient was found between 0.94 and 0.96. The scores obtained from the two scales varied between 20 and 80. Higher scores show higher levels of anxiety, and the lower scores show lower levels of anxiety.

2.6. Data analysis

2.6.1. Statistical analysis

The results of the study were analyzed in the IBM SPSS 25.0 [Statistical Package for Social Sciences IBM Corp., Armonk, NYC, USA] package program. The Kolmogorov–Smirnov test, histogram and normal Q-Q plot were used for tests of normality. Frequency and percentage were calculated for categorical variables. Means and standard deviations were calculated for age, performance skill score, anxiety level score, and satisfaction score. Independent group *t*-test was used to compare the scale mean scores. In all results, $p < 0.05$ was considered statistically significant.

3. Results

3.1. Descriptive characteristics of the participants

The mean age of the participants was 19.90 ± 1.74 in the Artificial Intelligence Assisted Interactive Screen-Based Simulation, and 70.6% of them were women. The mean age of the students in the standard patient simulation group was 19.43 ± 1.17 and 67.3% of them were women. In this study, no significant differences were noted among the groups in terms of the descriptive characteristics.

($p < 0.05$) (Table 3).

3.2. Comparison of the groups in terms of skill performance scores, anxiety levels and satisfaction levels.

The mean BSE Performance scores for the AI-AISBS and SPS groups were 59.71 ± 12.01 and 73.72 ± 15.53 respectively; the score was significantly lower in AI-AISBS group than SPS group. Looking at comparisons between the groups in terms of mean anxiety level, the state anxiety mean score of the students in the AI-AISBS group was 40.82 ± 8.17, while the students in the SPS group was 36.50 ± 8.23 and the difference was statistically significant. Regarding the comparison of total BFI severity scores between the two groups, the mean satisfaction score of the students in the AI-AISBS group was 56.59 ± 6.27, while the students in the SPS group was 50.45 ± 12.19 and the difference was statistically significant ($p < 0.05$) (Table 4).

4. Discussion

Changes are needed in the education system for better integration of active learning in the classroom and increased teaching of clinical reasoning. To achieve success, new and innovative teaching strategies must be integrated into nurse education (Joseph et al., 2021; MacKinnon et al., 2017). The aim of our study is to evaluate the effects of two different simulation types on students' skill performance score, satisfaction, and anxiety. To incorporate AI technology into nurse education

Table 3
Socio-demographic characteristics of the students in AI-AISBS and SPS groups.

Characteristics	AI-AISBS (n = 52)		SPS (n = 51)		Total		Test value	
	Mean		Mean		Mean		t	p
Age Average age	19.90 ± 1.74		19.43 ± 1.17		19.61 ± 1.24		−1.613[a]	0.110
	n	%	n	%	n	%	t	p
Sex								
Female	35	67.3	36	70.6	71	68.9	−0.356	0.722
Male	17	32.7	15	29.4	32	31.1		

$p < 0.05$.
[a] t: independent sample t-test.

Table 4
Comparison of the groups in terms of skill performance scores, anxiety levels and satisfaction levels.

	AI-AISBS (n = 52)	SPS (n = 51)	Test value	p
BSE mean score	59.71 ± 12.01	73.72 ± 15.53	5.126	0.000
Satisfaction mean score	56.59 ± 6.27	50.45 ± 12.19	−3.799	0.002
State anxiety mean score	40.82 ± 8.17	36.50 ± 8.23	−2.670	0.009

$p < 0.05$.
*t: independent sample *t*-test.

is important so that nurses are adequately informed and can improve patient outcomes in the evolving clinical and technical environment (Buchanan et al., 2021). In our study, it was determined that the BSE skill performance averages of the students in the AI-AISBS group were lower than the students in the SPS group (Table 4; $p < 0.05$). There are no studies comparing standard patient simulation and artificial intelligence assisted simulation in the literature. However, in a study on the effect of artificial intelligence assisted learning on genetic breast cancer risk; it was stated that when students communicate with an artificial intelligence with facial movements, communication becomes easier and learning is more effective and deeper than just giving information unlike our study results (Wolfe et al., 2013). The low BSE skill performance averages scores of the students in our study may be because the students participated in artificial intelligence assisted simulation for the first time, and the facial expressions, tone of voice and communication of the avatar used were like a real patient. In addition, it is thought that the avatar's ability to ask questions and give feedback to students creates stress, anxiety, and excitement in students.

Anxiety-inducing components limit self-efficacy development. Managing anxiety-inducing components assists consequent performance outcomes. The negative effects of anxiety can impede the learning process and serve as a barrier to performance and self-efficacy (Croy et al., 2020). For nursing students, new experiences can cause anxiety and may experience high levels of anxiety in both simulation and clinical learning environments (George et al., 2020; Yockey and Henry, 2019). In our study, the average score of the anxiety levels the students in the AI-ISBS simulation was found to be higher than the students in the SPS (Table 4; $p < 0.05$). Like our study results, it was stated in other studies that students' anxiety increased in virtual patient simulations (Cobbett and Snelgrove-Clarke, 2016; Reed and Ferdig, 2021), but the use of face-to-face clinical simulation and standard patient simulation decreased the level of anxiety in students (Ross and Carney, 2017; Cobbet Cobbett and Snelgrove-Clarke, 2016). It is thought that the high level of anxiety is because simulation applications create a new learning environment for students. Students reported the simulation as frightening and frustrating and the accompanying anxiety higher than experienced in clinical practice (Cantrell et al., 2017).

In nurse education, student satisfaction is essential because it affects how teaching and learning processes interact and whether simulation-based learning techniques may be used to enhance the learning outcomes (Jamie and Mohammed, 2019). In our study, the average score of satisfaction of the students in the artificial intelligence supported simulation group was found to be higher than the standard patient group (Table 4; $p < 0.05$). This is because students gain experience in communicating and using knowledge with AI-AISBS, reducing the learning complexity common in the real world. In the study, it was determined that the students' satisfaction levels were high from the artificial intelligence supported virtual reality application (Liaw et al., 2023). The results of this study were consistent with our study.

4.1. Limitations

However, the findings of this study are subjected to several limitations that need to be considered. First, a long-term assessment of students after the initial assessment could have provided more information. Second, there is scant evidence analyzing the use of artificial intelligence assisted screen-based practice in breast self-examination teaching as an education strategy method, which limits the discussion of our findings. Third, caution should be exercised when interpreting and generalizing the findings of this study because it was conducted with only a small sample size, so our results cannot be generalized.

5. Conclusion

This is the first study in which artificial intelligence simulation was used in breast self-examination in nurse education. The results of the research showed that the use of artificial intelligence-assisted simulation learning increased students' satisfaction, but at the same time students' anxiety increased. In addition artificial intelligence-assisted simulation learning is not as effective as SPS learning in gaining BSE skills. The use of different teaching environments including artificial intelligence supported screen-based simulation and standard patient simulations are an effective educational tool that helps students learn at their own pace and realize their mistakes by receiving instant feedback. By integrating standard patients and artificial intelligence supported simulation applications into traditional education methods, students for topics requiring skills in nurse education. It is recommended that studies using artificial intelligence and standard patient simulation should be carried out in nurse education.

Ethical considerations

In order to carry out the research, approval was obtained from the Clinical Research Ethics Committee of the University (number 2020-KAEK 143-57). Verbal and written consents of the students included in the study were obtained by informing them about the research. The research was conducted in accordance with the principles of the Declaration of Helsinki.

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CRediT authorship contribution statement

Study conception and design: SSC.
Data collection: All authors.
Data analysis and interpretation: All authors.
Drafting of the article: All authors.
Critical revision of the article: All authors.

Declaration of competing interest

The authors declare no conflicts of interest.

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