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The impact of intraoperative non-technical skills training on scrub practitioners' self-efficacy: a randomized controlled trial

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Abstract

Background Approximately half of all adverse events occur in the operating room, highlighting the critical role of non-technical skills in operating rooms. Effective non-technical skills among operating room nurses can significantly reduce the occurrence of such events. Moreover, self-efficacy in non-technical skills may directly impact professional performance and patient safety. Therefore, this study aimed to investigate the impact of intraoperative non-technical skills training on scrub practitioners' self-efficacy.

Methods In a randomized controlled trial, 30 scrub practitioners were assigned to the intervention group and 30 to the control group through random allocation. The intervention group underwent training in non-technical skills using a combined technique of lectures and simulated video scenarios delivered in two two-hour training sessions. Meanwhile, the control group received no training. The data collection tool was a two-part questionnaire. The first part collected demographic data (age, gender, work experience, and educational level), while the second part assessed scrub practitioners' self-efficacy in intraoperative non-technical skills. The questionnaire was administered online in two phases, with a one-month interval between them, through the Telegram application to the participants in both groups. The data were analyzed using descriptive statistics, independent t-tests, and paired t-tests.

Results The demographic variables of the intervention group did not show significant differences compared to the control group. The independent t-test revealed no significant difference in overall self-efficacy between the intervention and control groups before the training ($P=0.513$). However, after the training, a statistically significant difference was observed ($P=0.025$). There were no significant differences among the self-efficacy components between the intervention and control groups before the training ($P>0.05$). However, after the training, self-efficacy in the two skills of situation awareness and communication and teamwork showed statistically significant differences ($P<0.05$).

Conclusion Non-technical skills are crucial for scrub practitioners to perform their tasks safely and efficiently. Training can enhance the self-efficacy of scrub practitioners in their non-technical skills. Therefore, it is necessary to incorporate non-technical skills training into the educational curriculum and continuing education programs for scrub practitioners.

Trial registration The IRCT code (IRCT20150715023216N15) was obtained from the Iranian Clinical Trials Registry website on 2023/08/05 before sampling.

Keywords Non-technical skills, Self-efficacy, Scrub practitioners, Operating room nurses, Training

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Background

Patient safety, a key global public health issue [1], gained significant attention in healthcare organizations following the 2000 Institute of Medicine report, *To Err Is Human: Building a Safer Health System*. This report highlighted the prevalence of preventable adverse events [2]. Adverse events are unexpected medical issues that occur during treatment [3]. Preventable adverse events are estimated to impose a substantial financial burden, accounting for 8.7% of healthcare costs, excluding financial assistance or compensation [4]. Evidence shows that nearly half of adverse events occur in the operating room (OR) [5]. A systematic review and meta-analysis revealed that, despite international patient safety programs, the incidence of surgery-related adverse events between 2000 and 2019 remained at 20%, with half of these events considered preventable [6]. The 2024 WHO Global Report on Patient Safety highlights that approximately 7 million patients worldwide experience significant harm from surgery each year, with 1 million of them dying during or immediately after the procedure [7]. Adverse events in surgeries highlight the importance of non-technical skills (NTS)—cognitive, social, and personal skills that complement technical skills and play a critical role in performing tasks effectively and safely—in the operating room [8, 9]. Evidence suggests that deficiencies in these skills are associated with a higher risk of surgical complications and errors [9]. For instance, a study using the confidential claims database of the American College of Surgeons found that most surgical complications resulting in malpractice claims are not caused by intraoperative technical errors but by deficiencies in non-technical skills, such as poor communication [10]. Additionally, a 2017 study by Uramatsu and colleagues found that deficiencies in non-technical skills were a major contributing factor to adverse events in more than 50% of all fatal medical incidents [11].

Operating room nurses' competencies encompass perioperative technical skills [12] and non-technical skills such as teamwork, communication, situation awareness, and task management [13–16]. This branch of nursing encompasses two roles: scrub nurse and circulating nurse. The scrub nurse, also known as 'instrument nurse,' 'scrub practitioner,' 'operating department technician,' 'operating department practitioner,' or 'operating theatre technologist,' drapes the patient, manages instruments, and assists the surgeon. The circulating nurse, also called 'scout nurse,' 'circulator,' or 'floor nurse,' positions and disinfects the patient, assists the surgical team, manages tasks outside the sterile field, and acts as the patient's advocate [17, 18]. Previous studies have shown that by adopting strong non-technical skills, operating room nurses may help reduce the frequency of adverse events [19]. Unfortunately, until recently, non-technical skills in operating room nurses have been overlooked in nursing education and research [20]. Meanwhile, from an organizational perspective, there is an increasing need for non-technical skills training to improve patient care and safety in the Middle East and North Africa region [21]. Therefore, it is essential to integrate these skills into the education of operating room nurses [22].

One variable that may influence personal competency is self-efficacy (SE) [23]. Self-efficacy, or self-confidence, refers to the optimistic belief in one's ability to successfully perform a task. According to Bandura's theory, self-efficacy impacts the acquisition, development, and retention of new competencies and predicts future behavior [24]. Performing a task relies not only on skills but also on an individual's belief in their ability to perform well. As a result, individuals with the same knowledge and skills may perform poorly, adequately, or exceptionally, depending on fluctuations in their self-efficacy beliefs [25]. An ideal training program should effectively enhance both participants' skills and their self-efficacy [26]. The results of the systematic review and meta-analysis by Sánchez-Marco et al. (2023), which aimed to assess the effectiveness of educational interventions for non-technical skills in emergency medical services and critical care units, demonstrated that simulation-based interventions significantly improved emergency and intensive care professionals' knowledge, attitudes, self-efficacy, and performance in non-technical skills [27]. In their 2019 study, Ounounou and colleagues explored various methods for training surgeons in non-technical skills, including communication, teamwork, decision-making, and situation awareness. This systematic review identified several educational approaches, such as simulation-based learning, workshops, and team training exercises, that have been used to improve these critical skills. The study highlighted the significant impact of non-technical skills on surgeons' self-efficacy. Enhanced training in these skills is linked to higher self-efficacy among surgical trainees, leading to improved performance in high-risk settings. The findings suggest that greater proficiency in communication and collaboration among surgical teams enhances their overall effectiveness and leads to better patient outcomes [28].

Evidence indicates that self-efficacy in non-technical skills can influence performance and impact patient safety [26]. On the other hand, to the best of our knowledge, this is the first study to examine the effect of training in the Scrub Practitioner's List of Intraoperative Non-Technical Skills (SPLINTS) on the perceived self-efficacy of this group. Furthermore, the results of this study could serve as a foundation for designing standardized educational programs for operating room nurses,

particularly scrub practitioners, both nationally and internationally. Such programs could have a significant impact on improving patient safety and reducing surgical errors. Therefore, this study was conducted to assess the impact of intraoperative non-technical skills training on scrub practitioners' self-efficacy.

Methods

Study design

A randomized controlled trial (RCT) was conducted between May 2023 and February 2024 among scrub practitioners working at two public hospitals affiliated with Isfahan University of Medical Sciences in Iran. The study aimed to determine the impact of intraoperative non-technical skills training on scrub practitioners' self-efficacy. A coin toss was used to assign the hospitals to the intervention and control groups. Each scrub practitioner employed at these hospitals was assigned a unique number, and participants were then randomly allocated to the intervention or control groups using a random number table.

Blinding

This was a single-blind study, and the data analyst was unaware of which participants were assigned to the intervention group and which to the control group.

Sample size

The sample size was calculated based on a similar previous study [29] and using Formula 1, with a 95% confidence level and a power of the test of 80% for both the intervention and control groups. In this formula, the type I error (α) was set at 0.05, the type II error (β) at 0.2, the standard deviation of the intervention group (s_1) at 2.1, the standard deviation of the control group (s_2) at 1.77, and the effect size (d) at 1.5. According to this formula, each group's minimum number of participants was 27. Accounting for a dropout rate of 6 participants (10%), 30 were assigned to the intervention group and 30 to the control group.

$$n = \frac{\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 (s_1^2 + s_2^2)}{d^2} = 27$$

Formula 1: calculation of sample size

Ethical considerations

After obtaining approval for the study from the Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.NUREMA.REC.1402.044) and receiving the IRCT registration code (IRCT20150715023216N15) from the Iranian Clinical Trials Registry website on 2023/08/05, the researcher attended the operating rooms of both hospitals under study for three weeks, during morning and evening shifts. The researcher explained the study's objectives to all scrub practitioners working in these hospitals and answered any questions they might have. Those who met the inclusion criteria were invited to participate in the study. Scrub practitioners who were willing to participate completed an informed consent form before their participation.

The inclusion criteria for our study were as follows:

1. Being a scrub practitioner.
2. Willingness to participate in the study.

The exclusion criteria for our study were as follows:

1. Having less than six months of work experience at the current workplace.
2. Having prior experience participating in intraoperative non-technical skills training programs for scrub practitioners.

Data collection tool

The data collection tool was a questionnaire with two sections. The first section included demographic data (age, gender, work experience, and educational level), and the second section assessed the perceived self-efficacy in intraoperative non-technical skills of scrub practitioners. The questionnaire was administered online through the Telegram application both before and after the training and was distributed to participants in both the intervention and control groups.

The research team specifically developed the perceived self-efficacy in the intraoperative non-technical skills questionnaire for scrub practitioners (Table 1) based on the Persian version of the general self-efficacy questionnaire by Schwarzer and Jerusalem [30]. The questionnaire comprised 10 items derived from the classification elements of the Scrub Practitioner's List of Intraoperative Non-Technical Skills (SPLINTS) [31, 32] (Table 2). Participants responded to these items using a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The total scores on this scale ranged from 10 to 40, with higher scores reflecting greater self-efficacy in the intraoperative non-technical skills of scrub practitioners. The items in this questionnaire represented participants' positive self-perceptions of their intraoperative non-technical skills, particularly in the domains of situation awareness, communication and teamwork, and task management. The content validity of the perceived

Table 1 Perceived self-efficacy in the intraoperative non-technical skills questionnaire for scrub practitioners

SPLINTS category	Statements
Situation Awareness	- I constantly seek information in the operating room environment through observing, listening, and asking questions - I can interpret and use the information gathered from the operating room environment to understand ongoing events - I can anticipate what may happen in the future and what the surgeon may need in advance
Communication and Teamwork	- I always have sufficient confidence to request explanations and to clarify the necessary points to facilitate effective teamwork - I can seek and provide accurate and sufficient information to ensure a shared and mutual understanding among the surgical team members of the current conditions - I can effectively function as part of a team
Task Management	- I can organize and provide the necessary surgical items on time - I always ensure the safety of patients and staff - I always ensure compliance with the approved guidelines and protocols of the operating room - I can maintain a calm demeanor in stressful situations

Table 2 Prototype SPLINTS taxonomy (v 1.0)

Category	Elements
Situation Awareness	• Gathering information • Recognising and understanding information • Anticipating
Communication and Teamwork	• Acting assertively • Exchanging information • Co-ordinating with others
Task Management	• Planning and preparing • Providing and maintaining standards • Coping with pressure

self-efficacy questionnaire for intraoperative non-technical skills of scrub practitioners was confirmed through the feedback of 10 faculty members from the Department of Operating Room. The Content Validity Ratio (CVR) and the Content Validity Index (CVI) were calculated and validated. To assess reliability, a pilot study was conducted using the test–retest method with 30 scrub practitioners similar to the main study participants. After data collection, Cronbach's alpha coefficient for the questionnaire was calculated. The questionnaires were then redistributed to the same 30 scrub practitioners after three weeks, and the correlation between the data from the first and second assessments was calculated. The Cronbach's alpha coefficient for the questionnaire was 0.857.

Study flow

The researchers first developed educational content and simulated video scenarios for the intraoperative non-technical skills of scrub practitioners. To achieve this, the SPLINTS handbook was translated and reviewed by a medical text translation expert, a faculty member from the Department of Operating Room, and a faculty member from the Department of Medical Education. The SPLINTS system is a behavioral rating system used as a structured tool for training and assessing the intraoperative non-technical skills of scrub practitioners [31]. The system comprises three categories of non-technical skills: situation awareness, communication and teamwork, and task management. Each category includes three key elements that define the non-technical skills. It also provides examples of good and poor performance [33]. The research team then used the developed educational content to design and script video scenarios that reflected both good and poor performances by scrub practitioners in all three skill categories—situation awareness, communication and teamwork, and task management—during various surgical procedures. These video scenarios were subsequently filmed in a real operating room environment at a hospital that differed from those involved in the intervention and control groups. Operating room and anesthesia nurses were used as actors, preferably playing roles in their actual professional positions, to ensure that the simulated video scenarios were as realistic as possible. Nine video scenarios were produced, each lasting less than two minutes. Three scenarios focused on situation awareness, two on communication and teamwork, and four on task management skills (Table 3). The content of the video scenarios was reviewed and approved by ten faculty members from the Department of Operating Room.

In this study, the intervention group received training in non-technical skills through lectures and simulated video scenarios delivered over two two-hour sessions. In contrast, the control group did not receive any training. Before the training, an online questionnaire was distributed via the Telegram app to both the intervention and control groups. This questionnaire gathered demographic data and assessed participants' perceived self-efficacy in the intraoperative non-technical skills of scrub practitioners. The training sessions for the intervention

Table 3 Content of the video scenarios

Situation Awareness	Video Scenario 3	The surgeon and scrub practitioner are performing a right colectomy, and the surgery has reached the stage of closing the fascia. The surgeon requests a suture and instrument from the scrub practitioner but mistakenly names the instrument. Despite this, the scrub practitioner hands over the requested instrument to the surgeon. Additionally, the scrub practitioner forgets to ask the circulating practitioner for the suture needed to close the fascia. This video scenario reflects the poor performance of the scrub practitioner, and its educational objectives are as follows: "The scrub practitioner must provide the correct instrument even when the surgeon has not requested it or has mistakenly asked for something else." "The scrub practitioner should not request necessary items late."
Communication and Teamwork	Video Scenario 4	The surgeon and the scrub practitioner are beginning an abdominal hysterectomy. Instead of using a routine incision for the skin, the surgeon uses a different incision. Observing this change, the scrub practitioner asks the surgeon for the reason. This video scenario demonstrates the good performance of the scrub practitioner, and the educational objective is: "The scrub practitioner seeks an explanation if there is a deviation from the plan."
Task Management	Video Scenario 8	The surgeon and the scrub practitioner are performing a cesarean section. The baby has been delivered, and the patient's uterus is bleeding. The surgeon requests instruments from the scrub practitioner to remove the remnants of the placenta from the uterus, but the scrub practitioner finds and hands over the instruments with a delay. The educational objectives of this video scenario include: "The scrub practitioner should not show difficulty in locating the required equipment" and "The scrub practitioner should not present an unorganized workspace."

group were held in the operating room environment during their regular working hours. Due to the participants' varying work schedules, the researchers coordinated with them to conduct the training sessions over three separate days, with a one-day interval between each session. The second set of sessions was held immediately after the first training session. During the first session, situation awareness and task management skills were each taught for one hour. In the second session, communication and teamwork skills were taught to the intervention group for two hours. The structure of the training sessions was as follows: after a lecture on each skill, the corresponding simulated video scenarios were shown. Participants provided feedback on the performance of the scrub practitioner in these scenarios, followed by a detailed explanation and discussion of the videos. One month after the intervention group's training was completed [34], the online questionnaire assessing demographic data and perceived self-efficacy in intraoperative non-technical skills of scrub practitioners was re-sent to both the intervention and control groups (Fig. 1).

Statistical analysis

After coding and importing the data into statistical software, descriptive statistics (frequency distribution table, mean, and standard deviation) were used to describe the characteristics of the research sample. For quantitative variables, the mean and standard deviation were calculated. For qualitative variables, frequency and frequency percentages were determined. Chi-square tests were employed to examine the relationships between the qualitative variables in the two groups. To compare quantitative variables between the two groups, the normality of data distribution was assessed using the Shapiro–Wilk test. The independent t-test was conducted to compare the mean self-efficacy scores before and after the intervention. The paired t-test analysis was used to compare mean self-efficacy scores within the same group (intervention or control) before and after the training. All statistical tests were performed using SPSS 16 with a confidence level of 95% and a significance level of 0.05.

Results

Basic information

The demographic variables of the intervention group ($n=27$) compared to the control group ($n=27$) revealed no significant differences in age (mean ± SD) (34.51 ± 7.53 vs. 32.54 ± 7.22, $P=0.33$), The distribution of work experience is varied in both groups, but the differences in proportions are not statistically significant ($P=0.44$), sex distribution with 3.7% male and 96.3% female in the intervention group compared to 14.8% male and 85.2% female in the control group ($P=0.15$), The educational distribution was the same in both groups, with 3.7% holding an associate degree and 96.3% holding a bachelor's degree ($P=1.00$) (Table 4).

Analytical analysis

The independent t-test showed that the self-efficacy comparison between the intervention and control groups revealed no significant difference in pre-training ($P=0.513$). However, post-training showed a statistically significant difference ($P=0.025$). Among the components of self-efficacy, a comparison between the

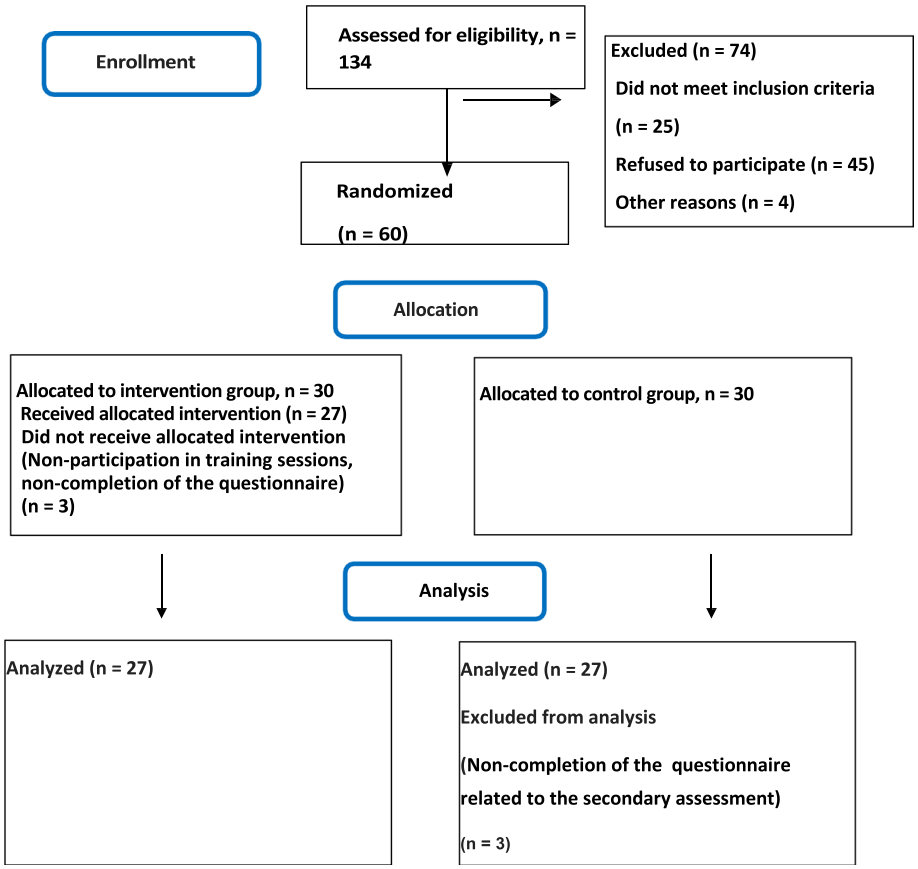

Fig. 1 Consort flow diagram

Table 4 Demographic variables of the intervention and control groups

Variable		Group		*P* value
		Intervention group ($n=27$)	Control group ($n=27$)	
Age (year) (mean ± SD)		34.51 ± 7.53	32.54 ± 7.22	$P=0.33$
Work Experience n (%)	1 to 5 years	8 (29.6%)	9 (33.3%)	$P=0.44$
	6 to 10 years	6 (22.2%)	9 (33.3%)	
	11 to 15 years	4 (14.8%)	5 (18.5%)	
	More than 15 years	9 (33.3%)	4 (14.8%)	
Sex n (%)	Male	1 (3.7%)	4 (14.8%)	$P=0.15$
	Female	26 (96.3%)	23 (85.2%)	

intervention and control groups revealed no significant difference in pre-training. However, the components of self-efficacy involving situation awareness, communication, and teamwork in the post-training showed a statistically significant difference ($P<0.05$). The paired t-test results showed that in the intervention group, the mean level of both situation awareness and communication and teamwork was significantly higher after the intervention than before the intervention ($P<0.05$); the mean levels of self-efficacy in task management were not significantly different between the two times in the groups ($P>0.05$) (Table 5).

Discussion

The present study aimed to determine the impact of intraoperative non-technical skills training on scrub practitioners' self-efficacy in these skills. The results showed that training intraoperative non-technical skills of scrub

Table 5 Comparison of self-efficacy of intervention and control groups

Variable	Group	Pre-training	Post-training	*P* value*
Overall self-efficacy (Mean ± SD)	intervention	31.33 ± 3.12	33.51 ± 4.02	0.005
	control	31.88 ± 3.06	31.07 ± 3.73	0.179
	P value**	0.513	0.025	
Situation Awareness (Mean ± SD)	intervention	9.29 ± 0.912	10.14 ± 1.16	0.002
	control	9.33 ± 1.10	9.33 ± 1.30	1.000
	P value**	0.894	0.019	
Communication and Teamwork (Mean ± SD)	intervention	9.25 ± 1.19	10.03 ± 1.50	0.008
	control	9.59 ± 1.04	9.03 ± 1.19	0.019
	P value**	0.281	0.009	
Task Management (Mean ± SD)	intervention	12.77 ± 1.88	13.33 ± 1.96	0.174
	control	12.96 ± 1.34	12.70 ± 1.75	0.388
	P value**	0.680	0.219	

*Paired t-test

**Independent t-test

practitioners, using a combined method of lectures and simulated video scenarios, significantly increased overall self-efficacy scores and self-efficacy related to situation awareness and communication and teamwork. Although task management self-efficacy scores improved in the intervention group after training, the increase was not statistically significant.

Effective communication is critical in high-risk environments such as the operating room, emergency department, and intensive care unit (ICU). Failures in this critical team process can lead to inefficient teamwork and poor patient outcomes, with potentially catastrophic results [35, 36]. Perioperative nurses collaborate closely with other specialists and provide advanced care to patients in critical conditions, requiring them to possess highly advanced knowledge and skills [37]. They need professional development training to be well-prepared for interprofessional teamwork [38, 39]. The World Health Organization (WHO) advocates for interprofessional collaboration as an educational approach to enhance effective practice and improve patient safety [40]. Furthermore, corresponding self-efficacy is equally crucial for healthcare providers to ensure they have the confidence needed to apply their skills effectively [41]. According to Bandura's theory, perceived self-efficacy is not a measure of an individual's skills but rather the belief in what they can achieve in various situations using their skills [42]. However, other research identifies self-efficacy as an essential criterion for assessing the impact of training on improving communication skills in healthcare [43].

Training in team processes, such as communication, increases self-efficacy [44]. Escher et al. (2023) conducted a study to examine the reactions of physicians and nurses to a simulation-based teamwork training program, focusing on their motivation for training, their self-efficacy related to performance, and their perspectives on the transfer of lessons learned to their workplace. In this study, participants' self-efficacy in teamwork significantly increased [45], which aligns with our research findings.

Perioperative nurses require advanced professional training that includes emotional, cognitive, and professional growth to achieve competency [38]. Therefore, simulation-based learning is employed, enabling nurses to perform routine tasks, develop effective communication techniques, and engage in higher-level learning through analysis and problem-solving [46]. In recent decades, educational research has increasingly focused on developing self-efficacy and its impact on behavior, learning processes, and student performance across various contexts [47]. Kaldheim et al. (2023) conducted a qualitative study in Norway to explore the experiences of newly graduated perioperative nurses with interprofessional simulation-based learning during their postgraduate education. The study examined how this learning approach contributed to developing their professional competency in facing acute clinical situations. Based on the findings, interprofessional simulation-based learning provided three advantages for these nurses: competence in managing acute conditions, interprofessional teamwork, and professional identity development. This study demonstrated that acquiring expert experiences through interprofessional simulation-based learning enhanced the participants' self-efficacy in teamwork [48]. The results of another study indicated that well-designed interprofessional simulation-based learning can enhance

self-efficacy in communication, interdisciplinary collaboration, and task prioritization in acute situations [49].

In a quasi-experimental study conducted by Escribano et al. (2024) involving final-year medical and nursing students, participants underwent an educational intervention utilizing high-fidelity simulation training to develop non-technical competencies. The findings demonstrated the intervention's effectiveness in enhancing perceived self-efficacy in problem-solving, leadership, resource management, situation awareness, and communication [50]. These results align with the findings of our study and previous research [51].

Jung et al. (2023) conducted a quasi-experimental study in Asia to examine the impact of a simulation-based educational program on patient safety management activity, patient safety management on the patient safety competency, communication self-efficacy, and teamwork of newly graduated nurses working in the intensive care unit. They found that the experimental group demonstrated significantly higher scores in patient safety competency and communication self-efficacy [52]. Previous research has also shown similar results [53, 54].

Haverkamp et al. (2023) conducted a mixed-methods study to evaluate the self-assessed technical and non-technical trauma skills of trauma care providers, including surgeons, anesthesiologists, and scrub nurses, and to gain insights into how these skills were integrated into new work situations after completing the Dutch Definitive Surgical Trauma Care (DSTC) and Anesthesia Trauma Care (DATC) courses. The study found that participants' self-efficacy in both technical and non-technical skills significantly improved following the course [55].

Liao et al. (2020) conducted a study involving first- and second-year surgical residents. The study showed that video coaching for technical and non-technical skills training significantly improved self-efficacy scores in non-technical skills—such as situation awareness, decision-making, communication and teamwork, and leadership—compared to traditional training methods [29]. This finding aligns with the results of our study.

In the study by Pena et al. (2015), researchers compared the perceived self-efficacy of surgeons and newly qualified surgical trainees in non-technical skills with their performance in simulated scenarios. Participants completed two simulation sessions, spaced six weeks apart, involving challenging non-technical skills scenarios. Some participants attended a non-technical skills workshop between the sessions. The study found a significant improvement in non-technical skills performance from the first to the second session; however, no correlation was observed between participants' self-efficacy and their performance in the scenarios in any comparison. Additionally, the overall perceived self-efficacy in non-technical skills and the perceived self-efficacy in each of these skills, including situation awareness, decision-making, communication and teamwork, and leadership, were higher after training than before training; however, no significant differences were observed [26]. The task management skills in scrub practitioners (Table 2) consist of three elements: planning and preparation, delivering and maintaining standards, and coping with pressure. In contrast, the leadership skills of surgeons, based on the Non-technical Skills for Surgeons (NOTSS) system used in the study by Pena et al., include three elements: setting and maintaining standards, coping with pressure, and supporting others [56]. Therefore, due to the similarity of the elements of these two skills in scrub practitioners and surgeons, we considered them equivalent in this study. With this analysis, the findings of the survey by Pena et al. were consistent with our study regarding self-efficacy in task management skills; however, they contradicted the other findings of our research, specifically the significant improvements in overall self-efficacy in non-technical skills, as well as in situation awareness and communication and teamwork. This paradox may be explained by the differences in the educational methods employed in the two studies. In the study by Pena et al., each participant was randomly assigned to either simulation scenario 1 or 2 during the first training session, followed by scenario 3. In the second session, participants were assigned to the alternative simulation scenario (compared to the first session), with scenario three repeated.

In summary, our study demonstrated that the educational intervention had a significant impact on the self-efficacy of scrub practitioners in their intraoperative non-technical skills. However, despite the improvement in the self-efficacy scores of scrub practitioners regarding task management skills, no significant differences were found between the intervention and control groups, nor before and after the training within the intervention group. This may be related to the limitations of our study regarding the delivery of the training. Given the high workload of scrub practitioners and the shortage of staff in hospitals, it was not feasible to conduct more training sessions or extend the duration of the existing training sessions.

Limitations

Limited sample size was one of the main limitations of this study. Although the sample size was sufficient for statistical analysis, expanding the study to include more hospitals or countries could have provided more comprehensive and generalizable results. In this study, the effects of SPLINTS training were assessed only shortly after the

intervention. Long-term studies are necessary to evaluate the sustainability and long-term effects of the training. Due to staffing shortages and the high workload of scrub practitioners, it was not feasible to conduct longer or more frequent training sessions, which could have potentially enhanced the effectiveness of the intervention.

Strengths

The use of a randomized controlled trial design, a standard method for reducing bias and enhancing the accuracy of results, was a major strength of this study. The implementation of the SPLINTS system, along with the validation of its translation by experts in nursing and medical education, ensured the scientific rigor and quality of the educational material provided. The design of video scenarios based on real-life situations and their use in training contributed to strengthening practical learning and improving the transfer of concepts. Our study examined the impact of training on three key non-technical skill components (situation awareness, communication and teamwork, and task management) individually, which allowed for a more precise analysis of the results. Organizing training sessions on different workdays and coordinating with participants demonstrated the research team's attention to practical conditions and efforts to minimize the additional burden on study participants.

Suggestions for future studies

Conducting research on a larger scale with more geographically and culturally diverse samples could enhance the generalizability of the findings from the current study. Future studies should focus on long-term follow-ups to assess the effectiveness of educational interventions in maintaining and consolidating self-efficacy in non-technical skills over extended periods. Comparing different educational methods for teaching the SPLINTS system may help identify the most effective approaches.

Conclusion

Non-technical skills are crucial for scrub practitioners to perform their tasks safely and efficiently. Training can enhance the self-efficacy of scrub practitioners in their non-technical skills. Therefore, it is necessary to incorporate non-technical skills training into the educational curriculum and continuing education programs for scrub practitioners.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07042-9.

Supplementary Material 1.

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Author's contributions

All authors have read and approved the manuscript. Study design: MM, AG, AO, MJT; Data collection and analysis: MM, MJT; Manuscript preparation: MM, AG.

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Data availability

The datasets used during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran, approved the study (Approval ID: IR.MUI.NUREMA.REC.1402.044). The researcher explained this to the participants and obtained their informed and voluntary consent. We confirmed that all methods were performed by the relevant guidelines and regulations.

Consent to publication

Not applicable.

Competing interests

The authors declare no competing interests.

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