

## Original Article

# Factors associated with participation in simulation-based training

Anders L. Schram<sup>1</sup>, Nadja L. Bonne<sup>1, 2</sup>, Tine B. Henriksen<sup>2, 3</sup>, Niels T. Hertel<sup>4</sup> & Morten S. Lindhard<sup>1, 2, 3</sup>

1) MidtSim, Department of Clinical Medicine, Aarhus University, 2) Department of Pediatrics and Adolescent Medicine, Aarhus University Hospital, 3) Department of Clinical Medicine, Aarhus University, 4) HC Andersen Children's Hospital, Odense University Hospital, 5) Department of Pediatrics, Regional Hospital of Randers, Denmark

Dan Med J 2025;72(7):A12240914. doi: 10.61409/A12240914

## ABSTRACT

**INTRODUCTION.** Simulation-based training is used to prepare healthcare professionals for clinical situations in a structured environment. However, participation varies depending on personal, professional and institutional factors. This study aimed to identify factors associated with participation to inform inclusive training programme designs.

**METHODS.** We analysed longitudinal data from 1,825 healthcare professionals across eight paediatric departments in two Danish regions over 15 months. Logistic regression was used to examine associations between simulation participation and factors such as age, gender, profession, experience, hospital type, sick leave, and patient safety culture.

**RESULTS.** Doctors were more likely to participate than nurses (OR = 1.5, 95% CI: 1.0; 2.1), and staff at regional hospitals were much more likely to participate than staff at university hospitals (OR = 4.8, 95% CI: 3.6; 6.2). Age, experience, sick leave, and safety culture dimensions showed trends, but none were statistically significant. Gender was not associated with participation.

**CONCLUSIONS.** Professional roles and institutional context may influence simulation participation. Tailored strategies targeting nurses, early-career professionals, and university hospital staff may help increase participation and support sustained training efforts.

**FUNDING.** The Elsass Foundation and the Central Denmark Region.

**TRIAL REGISTRATION.** Clinicaltrials.gov (no. NCT06064045).

Simulation-based training is used to prepare healthcare professionals for clinical situations in a structured environment [1-3]. Well-structured simulations have been shown to support coordination during acute care situations and may contribute to improved team performance under pressure [4]. Recent studies suggest that simulation-based training can improve preparedness for rare but critical events, prompting some institutions to invest in local simulation programmes [5, 6].

Despite its benefits, participation in simulation-based training remains uneven. Some healthcare professionals may feel uncomfortable engaging in training due to concerns about judgement, embarrassment or exposure [7]. Additionally, competing clinical responsibilities may limit engagement, particularly in systems where participation is voluntary [8]. Barriers such as time constraints or psychological discomfort may prevent experienced clinicians from participating, limiting the training's reach and practical relevance. Understanding who participates in simulation-based training and identifying factors influencing engagement is essential for designing more inclusive and effective training programmes.

In Denmark, simulation-based training is usually voluntary, and participation patterns may be shaped by structural and cultural factors within healthcare. High clinical demands and institutional priorities can create logistical challenges, further influencing engagement [9]. Addressing these barriers is crucial to ensuring equal access and maximising the impact of simulation-based training.

This study examined the personal, professional and institutional factors associated with participation in simulation-based training. Identifying key drivers and barriers provides insights into participation patterns and informs strategies to enhance engagement, supporting broader participation and more consistent integration into clinical practice [1].

## Methods

### Setting

This study is based on data from eight paediatric departments in two Danish healthcare regions [10]. One region increased the simulation-based team training, while the other region maintained standard practices. Standard practice was an average of eight monthly simulation sessions for each department. This reflects a national focus on using simulation to improve patient safety and professional competency. Simulation-based team training is a widely used educational modality for healthcare professionals in Denmark, supporting education and skill maintenance [11].

### Data collection and variable categorisation

Unique participant identifiers from simulation records were linked to administrative human resources databases [12] and the Danish Safety Attitudes Questionnaire (SAQ-DK) [13]. Variables included socio-demographics, sick leave rates and patient safety culture dimensions.

### Simulation participation

Participants were divided into two groups based on attendance: those who attended at least one session and those with no recorded participation. Simulations were conducted in situ, with local ambassadors documenting sessions in an online database. Data collection spanned from 1 January 1 2023 to 30 March 2024, with department collaborators ensuring completeness. The first author provided status updates every three weeks to maintain data quality. Across the eight departments, each session on average included 13 minutes for briefing, 22 minutes for scenario-based activities and 30 minutes for debriefing.

### Sociodemographic characteristics

The age groups were 22-34, 35-44 and 45-75 years. The profession was categorised as doctor or nurse, while years of experience were grouped into 0-9, 10-24 and over 24 years. Hospital affiliation was distinguished between university hospitals (10,000 employees) and regional hospitals (1,600-5,000 employees).

### Sick leave rates

Sick leave (April 2021-April 2023) was calculated as total sick leave hours divided by hours employed, accounting for part-time work and job changes [12]. Maternity leave and other absences were excluded. Participants were grouped into four quartiles: very low (0-0.5%), low (> 0.5-2.1%), high (> 2.1-5.0%) and very high (> 5%) [12].

### Assessment of patient safety culture

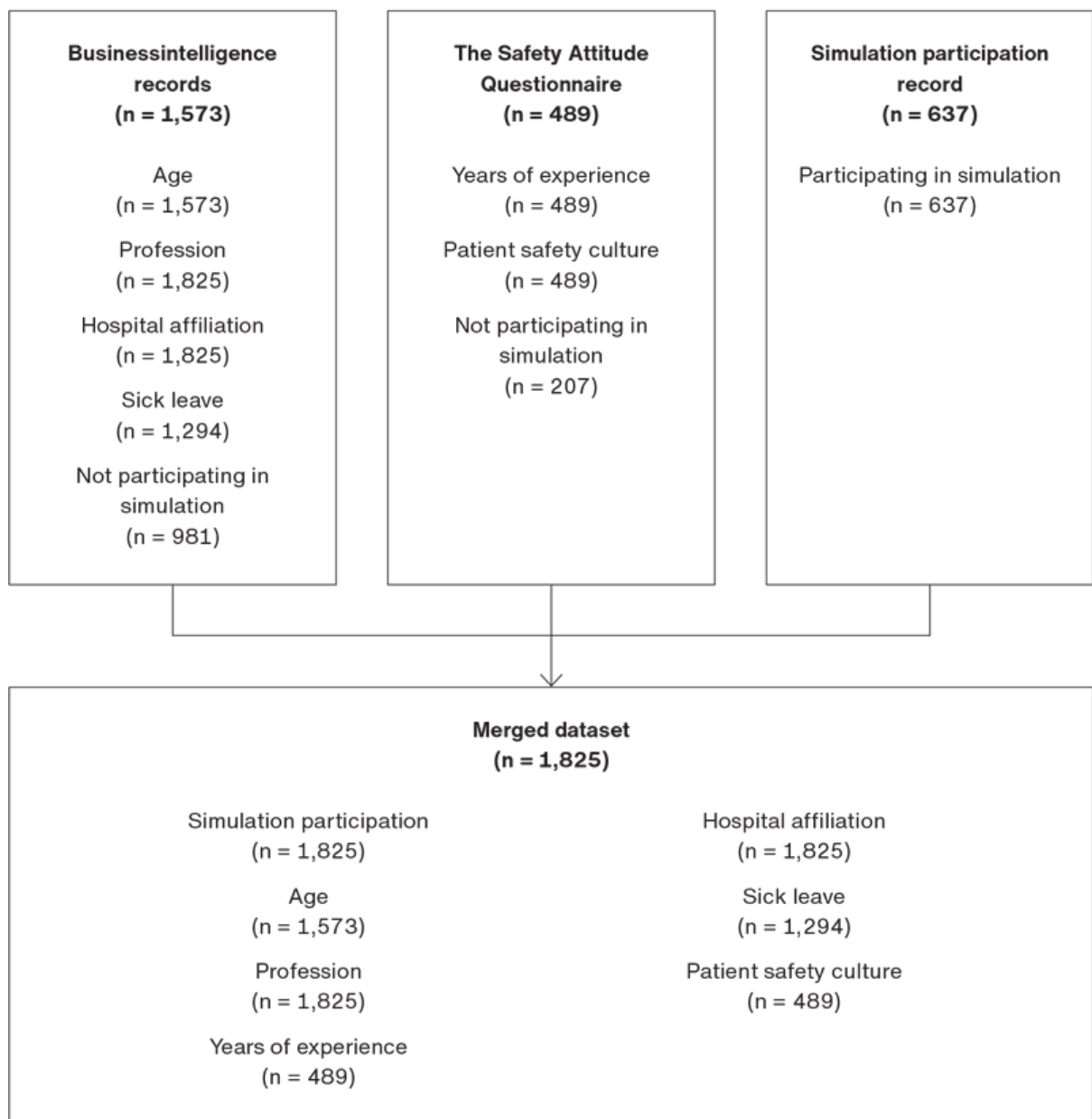
We used the validated SAQ-DK to assess healthcare employees' safety perceptions. In March-April 2023, it was distributed to doctors and nurses across eight paediatric departments, measuring six dimensions: teamwork climate, safety climate, job satisfaction, stress recognition, perception of management and working conditions.

The 36-item questionnaire used a 0-100 scale, with scores  $\geq 75$  indicating positive attitudes [13]. Among 2,440 distributed questionnaires, 1,412 were completed (58% response rate), of which 489 met the inclusion criteria requiring simulation participation data [13].

## Sample description

As illustrated in **Figure 1**, this study integrated data from the SAQ questionnaire, Business Intelligence (BI) records and simulation participation records.

**FIGURE 1** Overview of data sources and merged data, Denmark 2021-2023.



The SAQ included 489 observations on gender, profession, years of experience, hospital type and patient safety culture. BI records contained 1,573 observations on gender, profession, age, sick leave and hospital type. After merging, the final dataset comprised 1,825 unique observations. Key variables were simulation participation (n =

1,825), gender (n = 1,825), profession (n = 1,825), years of experience (n = 489), hospital type (n = 1,825), sick leave (n = 1,294), age (n = 1,573) and SAQ dimensions (n = 489). Simulation participation was based on electronic records, including 637 participants.

## Statistical analysis

Counts and proportions described categorical variable distributions, while logistic regression identified factors associated with simulation participation. Sociodemographic variables (gender, age, profession, experience, hospital type) and additional factors (sick leave rate, SAQ dimensions) were analysed separately to maximise sample size and minimise listwise deletion. All analyses were adjusted for the intervention/control group.

A multivariate model included group, age, profession, gender, hospital type, and sick leave, excluding experience and SAQ dimensions due to sample size limitations. Odds ratios (OR) with 95% confidence intervals (CI) were reported using Stata 18, with key assumptions verified. Further details are provided in [Appendix 2](#).

## Guidelines and ethics

The study followed the STROBE guidelines for reporting observational studies ([Appendix 1](#)). It was registered with the Regional Ethics Committee (1-16-02-232-22) and Aarhus University's GDPR system (no. 2016-051-000001). The Central Denmark Region Committees on Health Research Ethics (no. 1-10-72-124-22) confirmed that formal ethical approval was not required.

*Trial registration:* Clinicaltrials.gov (no. NCT06064045).

## Results

Among 1,825 participants, 637 (35%) participated in simulation-based training, while 1,188 (65%) did not.

**Table 1** shows adjusted logistic regression models for associations between participation and demographics, sick leave and patient safety culture.

**TABLE 1** Factors associated with participation in simulation with adjusted odds ratios, January 2023-March 2024.

Group	N	Simulation participants <sup>a</sup> n (%)	Odds ratio (95% CI)	
			group adjusted <sup>b</sup>	multivariate adjusted <sup>c</sup>
<i>Group</i>				
Control	892	224 (25)	1	1
Intervention	933	413 (44)	2.37* (1.94-2.89)	3.20* (2.42-4.23)
Total	1,825			
<i>Age group</i>				
22-34 yrs	657	222 (34)	1	1
35-44 yrs	406	166 (41)	1.33* (1.03-1.73)	0.96 (0.68-1.37)
45-75 yrs	510	177 (35)	1.05 (0.82-1.35)	0.97 (0.71-1.32)
Subtotal	1,573			
<i>Profession</i>				
Nurse	1,247	400 (32)	1	1
Doctor	578	237 (41)	1.57* (1.27-1.94)	1.46* (1.04-2.07)
Subtotal	1,825			
<i>Gender</i>				
Female	1,659	579 (35)	1	1
Male	166	58 (35)	1.04 (0.74-1.46)	0.96 (0.55-1.67)
Subtotal	1,825			
<i>Years of experience</i>				
0-9	227	106 (47)	1	1
10-24	146	65 (45)	0.92 (0.59-1.42)	Omitted <sup>d</sup>
> 24	116	48 (41)	0.74 (0.46-1.18)	Omitted <sup>d</sup>
Subtotal	489			
<i>Type of hospital</i>				
University	977	198 (20)	1	1
Regular hospital	848	439 (52)	4.57* (3.69-5.66)	4.77* (3.64-6.24)
Subtotal	1,825			
<i>Sick leave rate</i>				
Very low: 0-0.5%	324	123 (38)	1	1
Low: > 0.5-2.1%	324	120 (37)	1.06 (0.76-1.47)	1.14 (0.80-1.63)
High: > 2.1-5.0%	324	122 (38)	0.94 (0.68-1.30)	0.97 (0.67-1.39)
Very high: > 5%	323	107 (33)	0.71* (0.51-0.99)	0.91 (0.63-1.33)
Subtotal	1,294			
<i>Patient safety culture</i>				
Teamwork climate:				
Negative attitude	58	25 (43)	1	1
Positive attitude	431	194 (45)	1.17 (0.66-2.09)	Omitted <sup>d</sup>
Subtotal	489			
Safety climate:				
Negative attitude	205	88 (43)	1	1
Positive attitude	284	131 (46)	1.3 (0.89-1.91)	Omitted <sup>d</sup>
Subtotal	489			
Job satisfaction:				
Negative attitude	92	45 (49)	1	1
Positive attitude	397	174 (44)	0.89 (0.55-1.43)	Omitted <sup>d</sup>
Subtotal	489			
Stress recognition:				
Negative attitude	244	109 (45)	1	1
Positive attitude	245	110 (45)	1.02 (0.70-1.48)	Omitted <sup>d</sup>
Subtotal	489			

Continues >

**TABLE 1 (CONTINUED)** Factors associated with participation in simulation with adjusted odds ratios, January 2023-March 2024.

	N	Simulation participants <sup>a</sup> n (%)	Odds ratio (95% CI)	
			group adjusted <sup>b</sup>	multivariate adjusted <sup>c</sup>
Perceptions of management:				
Negative attitude	279	123 (44)	1	1
Positive attitude	210	96 (46)	1.28 (0.87-1.88)	Omitted <sup>d</sup>
Subtotal	489			
Working conditions:				
Negative attitude	129	61 (47)	1	1
Positive attitude	360	159 (44)	1.02 (0.67-1.56)	Omitted <sup>d</sup>
Subtotal	489			

\*) p < 0.05.

a) A total of 637 individuals participated in the simulation, whereas 1,188 did not.

b) The logistic regression models, with participation in simulation training as the dependent variable, were adjusted for the group (intervention/control) variable, except when analysing the group variable itself.

c) The multivariate logistic regression model adjusts for group, age, profession, gender, hospital type and sick leave; 1,161 observations.

d) Years of experience and patient safety culture dimensions were excluded from the adjusted model to preserve the number of observations as their inclusion would have considerably reduced the sample size.

Significant positive associations were observed in the multivariate model for group allocation, professional role and institutional context. As expected, being in the intervention group was strongly associated with higher participation (multivariate adjusted OR = 3.2, 95% CI: 2.4; 4.2). Doctors were 1.5 times more likely to participate than nurses (multivariate adjusted OR = 1.5, 95% CI: 1.0; 2.1). Staff at regional hospitals were 4.8 times more likely to participate than staff at university hospitals (multivariate adjusted OR = 4.8, 95% CI: 3.6; 6.2).

Non-significant positive trends were observed for years of experience and sick leave. Participation declined slightly with increasing experience, with lower odds for those over 24 years (group-adjusted OR = 0.74, 95% CI: 0.46; 1.18). Very high sick leave (> 5%) was associated with reduced participation in the group-adjusted model (OR = 0.71, 95% CI: 0.51; 0.99), but this was not significant in the multivariate model (OR = 0.91, 95% CI: 0.63; 1.33). Safety climate and perceptions of management showed favourable but non-significant ORs (OR = 1.3, 95% CI: 0.9; 1.9).

Gender and age showed no significant associations. Mid-career professionals (35-44) had slightly higher participation odds in the group-adjusted model (OR = 1.3, 95% CI: 1.0; 1.7), but this association was no longer present in the multivariate model (OR = 0.96, 95% CI: 0.7; 1.4).

### Discussion

To our knowledge, no previous studies specifically investigating which healthcare professionals engage in simulation-based training within a clinical paediatric setting. This study addressed this gap by identifying key factors influencing participation among paediatric department staff.

The significantly higher participation in the intervention group underscores the role of organisational focus and

facilitation. Studies indicate that simulation uptake increases when sessions are embedded into work schedules and supported by local facilitators or clinical leaders [14]. This suggests that institutional commitment and resources are crucial in shaping participation patterns.

Age alone did not significantly influence participation after adjusting for professional group, gender and workplace. While mid-career professionals (35-44 years) initially appeared more likely to participate, confounders may have explained this association. The variation in participation suggests that mid-career professionals may benefit from training formats aligned with their existing competencies and clinical responsibilities [15, 16].

Differences in professional roles may explain the higher participation rates among doctors than nurses. In paediatric departments, where nurses outnumber doctors, multi-professional training sessions may inadvertently favour doctors. Mid-career doctors also frequently engage in simulation, further contributing to this disparity. Sørensen et al. emphasised that well-structured simulations support team dynamics while exposing systemic barriers [17]. To address this imbalance, monodisciplinary simulations tailored to nurses could enhance relevance and preparedness [17].

Participation differences between regional and university hospitals highlight the influence of organisational structures. University hospitals face greater clinical demands and complexity, possibly limiting opportunities for simulation-based training [8]. One potential solution is integrating shorter, more frequent simulations into clinical workflows, aligning with the "low dose, high frequency training" approach to maintain training quality [17]. However, reducing session length would require careful content prioritisation, such as streamlining briefing and debriefing or focusing on specific high-impact skills rather than comprehensive case management. Securing administrative support remains crucial to ensure feasibility without compromising training effectiveness [17].

Higher individual sick leave rates were associated with lower participation, likely due to practical barriers such as scheduling conflicts or illness. While this association was significant in the group-adjusted model, it was not significant in the multivariate analysis, suggesting additional influencing factors. Flexible scheduling or embedding training within routine work structures may potentially mitigate this barrier and ensure broader access.

No significant associations were found between years of experience, patient safety culture dimensions and participation, possibly due to the sample size ( $n = 489$ ), which may have limited statistical power. However, the positive ORs for safety climate and perceptions of management suggest that these dimensions may still foster engagement. A strong safety culture likely creates a psychologically safe environment where professionals feel encouraged to participate, recognising its value for teamwork, communication and professional development [4, 18]. Conversely, simulation-based training may reinforce safety culture by supporting peer learning and clarifying roles during high-risk scenarios [19]. How culture drives participation or vice versa remains unclear, as these factors likely interact.

Lower participation among experienced staff may reflect perceptions that simulation challenges their expertise or is less relevant to their roles. However, specialist training programmes often incorporate simulation, engaging certain mid-career professionals more frequently. Given that career trajectories vary – nurses typically reach mid-career earlier than physicians – tailored strategies are needed to accommodate different professional pathways. Reframing simulation as a means to maintain clinical acuity in infrequently performed but critical procedures [19].

## **Strengths and limitations**

The strengths of this study include its multi-site design across two healthcare regions and eight departments, enhancing generalisability. Symmetric simulation registration over 15 months ensured accurate participation data, while robust statistical analyses, including individual and multivariate logistic regression models, allowed for assessing independent predictors. With a large sample of 1,825 healthcare professionals, the study was well-powered to detect meaningful associations and trends, strengthening its reliability.

However, limitations exist. The use of self-reported questionnaires introduces a risk of reporting bias. Additionally, the inability to distinguish trainee doctors from specialists may have limited insights into participation patterns. The focus of this study on paediatrics in Danish healthcare may also limit its generalisability to other departments or countries. While all simulations were conducted in situ, the absence of data from off-site simulations may restrict the understanding of how the setting influences participation. Nonetheless, these findings likely have broader relevance, as professional roles, institutional context and training needs are common across healthcare systems [9, 20].

## Conclusions

Our study highlights factors positively associated with healthcare professionals' participation in simulation-based training, particularly staff in the 35-44-year age group, physician roles and affiliation with regional hospitals. Tailoring training to the needs of early-career professionals, experienced staff and nurses may boost engagement. Training formats that accommodate staffing realities and institutional constraints may support more sustained participation.

**Correspondence** *Anders L. Schram*. E-mail: [anders.schram@rm.dk](mailto:anders.schram@rm.dk)

**Accepted** 2 April 2025

**Published** 12 June 2025

**Conflicts of interest** ALS reports financial support from or interest in the Elsass Foundation & Central Denmark Region. MSL reports financial support from or interest in Central Denmark Region's Health Science Research Foundation. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. These are available together with the article at [ugeskriftet.dk/dmj](https://ugeskriftet.dk/dmj)

**Acknowledgements** We extend our deepest gratitude to the dedicated staff in the paediatric departments of the Central Denmark Region and the Region of Southern Denmark. Your collaboration and commitment were invaluable in ensuring comprehensive and accurate data collection for this study. In particular, we would like to acknowledge the following individuals for their exceptional contributions: *Pernille Petersen, Maja Bjerrum, Lone Paulsen, Martin Hulgaard, Cecilie Rutkjaer, Sofie Sommer, Lotte Hansen, Camilla Hesselberg, Pernille Vandborg, Signe Thim, Rikke Kaae, Thala Snerum* and *Arlen Canenguez*.

**References** can be found with the article at [ugeskriftet.dk/dmj](https://ugeskriftet.dk/dmj)

**Cite this as** *Dan Med J* 2025;72(7):A12240914

doi [10.61409/A12240914](https://doi.org/10.61409/A12240914)

**Open Access** under Creative Commons License [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)

**Supplementary material:** <https://content.ugeskriftet.dk/sites/default/files/2025-04/a12240914-supplementary.pdf>

## REFERENCES

1. Lateef F. Simulation-based learning: just like the real thing. *J Emerg Trauma Shock*. 2010;3(4):348-52. <https://doi.org/10.4103/0974-2700.70743>

2. Aggarwal R, Mytton OT, Derbrew M, et al. Training and simulation for patient safety. *Qual Saf Health Care*. 2010;19(suppl 2):i34-i43. <https://doi.org/10.1136/qshc.2009.038562>
3. Abildgren L, Lebahn-Hadidi M, Mogensen CB, et al. The effectiveness of improving healthcare teams' human factor skills using simulation-based training: a systematic review. *Adv Simul (London)*. 2022;7(1):12. <https://doi.org/10.1186/s41077-022-00207-2>
4. Rosen MA, DiazGranados D, Dietz AS, et al. Teamwork in healthcare: key discoveries enabling safer, high-quality care. *Am Psychol*. 2018;73(4):433-50. <https://doi.org/10.1037/amp0000298>
5. Bienstock J, Heuer A. A review on the evolution of simulation-based training to help build a safer future. *Medicine (Baltimore)*. 2022;101(25):e29503. <https://doi.org/10.1097/MD.00000000000029503>
6. Hippe DS, Umoren RA, McGee A, et al. A targeted systematic review of cost analyses for implementation of simulation-based education in healthcare. *SAGE Open Med*. 2020;8:2050312120913451. <https://doi.org/10.1177/2050312120913451>
7. Dieckmann P, Friis SM, Lippert A, et al. The art and science of debriefing in simulation: ideal and practice. *Med Teach*. 2009;31(7):e287-e294. <https://doi.org/10.1080/01421590902866218>
8. Weissman JS, Rothschild JM, Bendavid E, et al. Hospital workload and adverse events. *Med Care*. 2007;45(5):448-55. <https://doi.org/10.1097/01.mlr.0000257231.86368.09>
9. Salas E, Wilson KA, Burke CS, et al. Using simulation-based training to improve patient safety: what does it take? *Jt Comm J Qual Patient Saf*. 2005;31(7):363-71. [https://doi.org/10.1016/s1553-7250\(05\)31049-x](https://doi.org/10.1016/s1553-7250(05)31049-x)
10. Schram A, Bonne NL, Henriksen TB, et al. Simulation-based team training for healthcare professionals in pediatric departments: study protocol for a nonrandomized controlled trial. *BMC Med Educ* 2024;24(1):607. <https://doi.org/10.1186/s12909-024-05602-z>
11. Sundhedsstyrelsen. Simulationsbaseret træning i den lægelige videreuddannelse. Version: 1. Sundhedsstyrelsen, 2019
12. The BI Office. Description of the BI Data Warehouse for research purpose in Central Denmark Region. The BI Office, 2024: 2. [www.rm.dk/contentassets/7b6dcaf5c7554c139b4ec054822bc4cf/reference-til-forskning.pdf](http://www.rm.dk/contentassets/7b6dcaf5c7554c139b4ec054822bc4cf/reference-til-forskning.pdf) (Nov 2024)
13. Kristensen S, Sabroe S, Bartels P, et al. Adaption and validation of the Safety Attitudes Questionnaire for the Danish hospital setting. *Clin Epidemiol*. 2015;7:149-60. <https://doi.org/10.2147/CLEP.S75560>
14. Elendu C, Amaechi DC, Okatta AU, et al. The impact of simulation-based training in medical education: a review. *Medicine (Baltimore)*. 2024;103(27):e38813. <https://doi.org/10.1097/MD.00000000000038813>
15. Motola I, Devine LA, Chung HS, et al. Simulation in healthcare education: a best evidence practical guide. *AMEE Guide No. 82. Med Teach*. 2013;35(10):e1511-e1530. <https://doi.org/10.3109/0142159X.2013.818632>
16. Khalaila R. Simulation in nursing education: an evaluation of students' outcomes at their first clinical practice combined with simulations. *Nurse Educ Today*. 2014;34(2):252-8. <https://doi.org/10.1016/j.nedt.2013.08.015>
17. Sørensen JL, Lottrup P, van der Vleuten C, et al. Unannounced in situ simulation of obstetric emergencies: staff perceptions and organisational impact. *Postgrad Med J*. 2014;90:622-9. <https://doi.org/10.1136/postgradmedj-2013-132280>
18. Grissinger M. Disrespectful behavior in health care: its impact, why it arises and persists, and how to address it - Part 2. *P T*. 2017;42(2):74-7
19. Purdy E, Alexander C, Caughley M, et al. Identifying and transmitting the culture of emergency medicine through simulation. *AEM Educ Train*. 2019;3(2):118-28. <https://doi.org/10.1002/aet2.10325>
20. Gaba DM. The future vision of simulation in health care. *Qual Saf Health Care*. 2004;13(suppl 1):i2-i10. [https://doi.org/10.1136/qhc.13.suppl\\_1.i2](https://doi.org/10.1136/qhc.13.suppl_1.i2)