RBEM Revista Brasileira de Educação Médica

ORIGINAL ARTICLE

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

The perception of the medical student about realistic simulation in pediatrics

A percepção do estudante de medicina sobre a simulação realística em pediatria

Nathalia Veiga Moliterno[1,2] nathaveiga@hotmail.com
Eneida Quadrio de Oliveira Veiga[2] eneida@prof.unifase-rj.edu.br
Patrícia Zen Tempski[3] patricia.tempski@fm.usp.br
Antônio José Ledo Alves da Cunha[1,4] antonioledo@yahoo.com.br
Arnaldo Prata-Barbosa[1,4] arnaldo.prata@idor.org
Maria Clara de Magalhães-Barbosa[1] mariaclara.magalhaes@idor.org

ABSTRACT

Introduction: The use of realistic simulation in pediatric emergencies is particularly valuable, as it allows the training of technical, attitudinal, and cognitive skills, helping to ensure patient safety.

Objective: This study aims to describe the student's perception of using the High-Fidelity Realistic Simulation in the pediatric emergency modules during the internship.

Methods: Observational, descriptive study with a quantitative and qualitative approach. A semi-structured questionnaire was applied to sixth-year medical students at the end of the pediatric internship modules, which lasted eight weeks, from August to December 2020. All of them participated in two types of activities on 14 topics: high-fidelity simulation (HFS) and structured discussion of clinical cases (SDCC).

Results: Of the 33 participants, 29 answered the questionnaire. The mean age was 24 ± 1.8 years, and 58.6% were female. All agreed that the experience with HFS contributed to safer performance in pediatric emergencies, considered optimal by 76% and good for the remainder. Most thought the association of HFS and SDCC was the ideal method (96%). The content analysis of the responses on HFS highlighted thematic units in five categories: significant learning, contribution to professional training, skills, attitude/behavior, and quality of the activity.

Conclusions: Students' reaction to using HFS in pediatric emergencies was very positive, and its association with SDCC was considered the ideal teaching method. Knowing the students' reactions helps teachers plan their activities to improve the teaching-learning method.

Keywords: High-Fidelity Simulation Training; Pediatrics; Medical education; Personal Satisfaction; Qualitative Research.

RESUMO

Introdução: *O uso de simulação realística em emergências pediátricas é particularmente valioso, pois permite o treinamento de habilidades técnicas, atitudinais e cognitivas, ajudando a garantir a segurança do paciente.*

Objetivo: *Este estudo tem como objetivo descrever a percepção do aluno sobre o uso da Simulação Realista de Alta Fidelidade nos módulos de emergência pediátrica durante o internato de medicina.*

Métodos: *Estudo observacional, descritivo, com abordagem quantitativa e qualitativa. Um questionário semiestruturado foi aplicado aos estudantes do sexto ano de medicina ao final dos módulos de internato pediátrico, com oito semanas de duração, de agosto a dezembro de 2020. Todos participaram de dois tipos de atividades sobre 14 temas: simulação de alta fidelidade (SRAF) e discussão estruturada de casos clínicos (DCC).*

Resultados: *Dos 33 participantes, 29 responderam ao questionário. A média de idade foi de 24 ± 1,8 anos, sendo 58,6% do sexo feminino. Todos concordaram que a experiência com SRAF contribuiu para um desempenho mais seguro em emergências pediátricas, considerado ótimo por 76% e bom para os demais. A maioria achava que a associação de SRAF e DCC era o método ideal (96%). A análise de conteúdo das respostas sobre a SRAF destacou unidades temáticas em cinco categorias: aprendizagem significativa, contribuição para a formação profissional, habilidades, atitude/comportamento e qualidade da atividade.*

Conclusões: *A reação dos estudantes ao uso da SRAF em emergências pediátricas foi muito positiva, e sua associação com a DCC foi considerada o método de ensino ideal. Conhecer as reações dos alunos ajuda os professores a planejarem suas atividades para melhorar o método de ensino-aprendizagem.*

Palavras-chave: *Simulação Realística de Alta Fidelidade; Pediatria; Educação Médica; Satisfação Pessoal; Pesquisa Qualitativa.*

[1] Instituto D'Or de Pesquisa e Ensino, Rio de Janeiro, RJ, Brasil.
[2] Faculdade de Medicina de Petrópolis, Petrópolis, RJ, Brasil.
[3] Universidade de São Paulo, São Paulo, SP, Brasil.
[4] Instituto de Puericultura e Pediatria Martagão Gesteira, Universidade Federal do Rio de Janeiro, RJ, Brasil.

Chief Editor: Rosiane Viana Zuza Diniz.
Associate Editor: Fernando Almeida.

Received on 04/11/23; Accepted on 11/29/23.

Avaliado pelo processo de *double blind review.*

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

INTRODUCTION

In the 1980s, medical simulation pioneers developed immersive simulation environments in which professionals could interact with the patient simulator and clinical setting, allowing trainees to solve clinical problems in real time. Until then, the simulation technique was restricted to high-risk industries, mainly to aviation[1]. Since then, simulation has gained significant attention and has been widely adopted as a training and evaluation tool in medical education[2].

Historically, pediatric residents have acquired experience in resuscitation and technical procedures in direct contact with patients at the bedside in emergency departments, intensive care units, or hospital wards[3]. However, considering the changes over time, such as decreased hours of residents and increased commitment to patient safety, there was a strengthening of the use of realistic simulation[4]. In pediatrics, realistic simulation is particularly valuable since severe acute events occur with low frequency. Consequently, students and residents are less exposed to training in these clinical situations[2,5,6]. Substantial evidence suggests that simulation improves team performance and management in resuscitation and trauma situations[2].

The fidelity of Realistic Simulation can be divided into low, medium, and high – the more similar to real-life situations, the more accurate the simulation[6,7]. High-Fidelity Simulation (HFS) incorporates a full-body computerized simulator that can be programmed to provide a real physiological response to students' actions[8]. According to Cheng, HFS has a great advantage over low- and medium-fidelity because it can show physical findings and accurate physiological responses. Still, its disadvantage is the high cost, which often prevents its implementation[9].

The realistic simulation can be divided into four moments: **the creation** of the scenario with well-defined and feasible objectives; **the briefing**, the moment of familiarization of the students with the simulator and the setting; the **simulated scenario**, when the student plays the role of a health professional providing patient care; and, finally, **the debriefing**, which in the educational context is based on the learning generated by the students' reflection, individually or in group, on the performance after a given task. Thus, debriefing could be better understood as "post-experience reflection"[10–12].

Not every simulated scenario is followed by debriefing. However, it is known that performing this step makes learning more meaningful. This teaching strategy can lead to student engagement and motivation, as they often feel challenged and encouraged, get to know their limits, and seek to improve. During the debriefing, the student analyzes their performance, which can generate a trigger to be overcome in the following simulated scenario[13].

Some studies suggest that student satisfaction with the use of realistic simulation is high when compared to other teaching methodologies, such as discussion of clinical cases[4,14,15].

This study aims to describe the student's perception regarding the use of High-Fidelity Realistic Simulation (HFS) and Structured Discussion of Clinical Cases (SDCC) in the pediatric emergency module during the pediatric internship. Both are active methodologies that have emerged as an alternative to traditional teaching and aim to collaborate to train professionals capable of promoting knowledge aggregation and its applicability to the most minor and most complex problems. They are centered on the student, the active subject of the learning process, for critical, effective, and collaborative formation[16].

METHODS

This study was approved by the Research Ethics Committee of the participating institution (CAAE: No.83366618.1.00005245). All participants signed the informed consent form before being included in the study.

Study design and location

This is a descriptive, cross-sectional study with a quantitative and qualitative approach to the data obtained through a questionnaire applied to students attending the 6th year of medical school. These students were attending the pediatric emergency modules during the Pediatric Internship, from August to December 2020, at the Faculty of Medicine of a University Center of the state of Rio de Janeiro, Brazil.

Study participants and procedures

The study included 33 students who participated in two identical modules in the second semester of 2020: 23 students from August to October and ten from October to December. The study modules were adapted to address 14 pediatric emergency topics per module, using HFS and SDCC. The students of each module were divided into two groups. The first seven topics were addressed as realistic simulation for group A and as case discussion for group B. In the approach of the following seven topics, the methodology was reversed between the groups so that all students had the opportunity to experience both methods throughout the module.

High-fidelity simulation activity

The pediatric HFS team comprises eight teachers with experience in pediatric emergencies: one professor with a Ph.D., four with a master's degree, and three board-certified pediatricians. The realistic simulation laboratory has a physical area of 400 m^2, with offices and emergency

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

training rooms (pediatrics, obstetrics, clinical, and surgical rooms), unidirectional glass for simultaneous observation, a home care training room, a semiology training room, and two rooms for debriefing. For pediatrics, it has two Integrated simulators considered high-fidelity (Baby Sim and PediaSim, Civiam). All simulated scenarios used one of these two simulators.

The realistic simulation laboratory and simulators were introduced to the students by the teachers, highlighting the potential of the equipment. Groups of 6 to 8 students participated in each simulated scenario: two students as medical staff, one assigned as a leader, the other as part of the team, and the remainder as observers. Before starting each simulated scenario, a scenario briefing was performed to define the student's environment. Three instructors participated in all simulation activities, two acting as a nurse or companion of the child receiving care, and the third in the simulator's control room, behind the unidirectional glass, directing the physiological responses of the simulator according to the decisions made by the students, in addition to answering through audio some questions about reactions that the simulator did not show, such as changes in skin color, for example. The simulation activities lasted around 60 minutes: the briefing about 2 minutes; the simulated scenario about 15 to 20 minutes, and the debriefing about 35 to 40 minutes. The debriefing was held with all participants (active and observers) to discuss the student's performance, disclosure of doubts, citation of the positive points, and points to be improved, in addition to discussion of the topic. The debriefing was considered a fundamental phase of the realistic simulation to consolidate learning and acquire the desired competencies.

Structured discussion of clinical cases activity

The clinical cases were presented through the disclosure of images on slides, followed by a discussion with the active participation of the students to solve the proposed problems. The case discussions lasted 60 minutes for each clinical case, and a gamified strategy (pedagogical methodology based on games) was used. In this strategy, the students were randomly divided into two groups to solve the clinical cases. At the end of the time provided, each group presented its answers, thus setting up a healthy competition that generated student motivation.

Covered topics

The following topics were addressed in each module 1) Wheezing infant; 2) Hypovolemic shock; 3) Septic shock of pulmonary focus; 4) Insect bite anaphylaxis in a school patient; 5) Neonatal hypoglycemia; 6) Febrile convulsive crisis; 7) Exogenous organophosphate poisoning; 8) Asthma; 9) Hypoglycemia in a school patient; 10) Stridulous laryngitis; 11) Anaphylaxis in infants; 12) Snakebite accident; 13) Acute bacterial meningitis; 14) Benzodiazepine poisoning. The first seven topics were addressed as HFS for group A and SDCC for group B. In the following seven topics, the groups changed the type of training (SDCC for group A and HFS for group B).

Data collection instrument

A semi-structured questionnaire was created to be filled out anonymously by the students at the end of each module to evaluate their reactions. This instrument was prepared by pediatric professors who were used to practicing HFS and SDCC. It consisted of 11 open questions, seven multiple choice questions, and 19 questions with five-level Likert-type answers (I strongly agree, I agree, I do not know, I disagree, and I strongly disagree), in addition to a sociodemographic questionnaire, which included objective questions such as age, gender, undergraduate period, previous courses, previous exposure to realistic simulation, as well as questions about the student's perception of teaching methodologies. Among the addressed items, the highlights were HFS's contribution to student safety (self-confidence), the degree of relevance of the covered topics, evaluation of the realistic simulation laboratory infrastructure, the quality of the simulator, items about the debriefing (feeling comfortable to present questions, the connection between simulation and real life, reflection on behavioral aspects), and questions comparing HFS activity with SDCC. The open questions were about, for example, citing weaknesses and strengths related to the HFS, listing the most relevant covered topics, and the free space to report the student's experience. (Additional file available at: https://assets.researchsquare.com/files/rs-2143045/v1/a1c9b7ccb103260ed3cce3ba.docx).

Data analysis

In the quantitative analysis, categorical variables were described as percentages and continuous variables as means and standard deviations or medians and interquartile intervals, according to their distribution. Likert-type responses were shown as percentages. For the qualitative analysis, a content analysis method described by Laurence Bardin was used, following three steps: content organization in Excel spreadsheets, coding, and categorization[17]. After the pre-analysis with floating reading, the material was explored so the speeches could be categorized. The units of record used in this study were the characteristics of the realistic simulation method attributed by the students.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

RESULTS

All 33 students agreed to participate in the study, but four (12.1%) were excluded because they did not fill out the questionnaire at the end of the module, leaving 29 students for the final data analysis. Among the participants, 17 (58.6%) were female, the mean age was 24 ± 1.8 years, all attended the 6th year of medical school, 18 (62.1%) had never participated in a realistic simulation activity, and 16 (55.2%) considered the simulated scenario the most valuable stage for learning compared to briefing and debriefing phases.

Regarding the realistic simulation activity, the percentage of students who responded positively (strongly agreed or agreed) to the statements that reflected the method's benefits ranged from 86 to 100%. As for the debriefing, this percentage ranged from 93 to 100% of the students (Table 1).

The topics considered the most relevant for learning were anaphylaxis (31%), septic shock (27.5%), meningitis (10.3%), and dehydration (10.4%). Experience in realistic simulation activities was rated excellent by 22 students (75.9%) and good by seven (24.1%). On the other hand, their performance in the activities was classified as excellent by seven students (24.1%), good by 20 (69.0%), and bad by two (6.9%).

Regarding the SDCC, 55.2% of the students reported a similar contribution to the realistic simulation for learning, 34.5% reported a smaller contribution, and 10% reported a higher contribution. Compared to lecture-based learning, 62% responded that the SDCC made a greater contribution. All students reported enjoying the SDCC activities, and 96% chose the association of the HFS with the SDCC as the best teaching method for the pediatric emergency module (Table 2).

Table 1. Frequency of responses to the HFS-related student reaction questionnaire (n=29).

Considerations on the simulation activity	I strongly disagree	I disagree	I agree	I strongly agree	I don't know
Do you think realistic simulation will help you act more safely when dealing with pediatric emergency situations?	0	0	3 (11%)	26 (89%)	0
Do you think that realistic simulation in pediatrics should be introduced earlier into the curriculum?	2 (7%)	2 (7%)	10 (34.5%)	15 (51.7%)	0
Did you find the simulation lab infrastructure adequate?	0	0	11 (38%)	18 (62%)	0
Has the quality of the simulator (robot) used in the activity met your expectations?	0	0	16 (55%)	13 (45%)	0
Had you studied the topic discussed before your participation in the simulation?	0	14 (48.3%)	10 (34.5%)	5 (17.2%)	0
Did you study the covered topic after your participation in the simulation?	1 (3.5%)	0	18 (62%)	10 (34.5%)	0
Were the topics addressed during the module, both in the realistic simulation and in the discussion of clinical cases relevant to your training as a general practitioner?	0	0	3 (10.3%)	26 (89.7%)	0
Considerations on the debriefing	**I strongly disagree**	**I disagree**	**I agree**	**I strongly agree**	**I don't know**
Did you feel comfortable disclosing your doubts during the debriefings?	0	0	7 (24,2%)	22 (75,8%)	0
Did the debriefings help you make connections between theory and real medical situations?	1 (3,5%)	0	5 (17,2%)	23 (79,3%)	0
Have the debriefings provided you with learning opportunities?	0	1 (3,5%)	3 (10,3%)	25 (86,2%)	0
Did the debriefings help you clarify your doubts?	0	0	4 (13,8%)	25 (86,2%)	0
Did the debriefings provide a means for you to reflect on your actions during the simulation?	1 (3,5%)	0	3 (10,3%)	25 (86,2%)	0
Did the teacher perform a constructive evaluation during the debriefing session?	1 (3,5%)	0	7 (24,2%)	21 (72,3%)	0
Did the teacher reinforce behavioral/attitudinal aspects of the health team?	0	0	7 (24,2%)	22 (75,8%)	0
At the end of the debriefings, did the teacher recommend reading on the addressed topic?	1 (3,5%)	1 (3,5%)	11 (38%)	16 (55%)	0
Was the approach format (simulation + discussion) of the topics used in this module beneficial?	0	1 (3,5%)	3 (10,3%)	25 (86,2%)	0

HFS - High Fidelity Simulation.
Source: Questionnaire prepared by the research team.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

Table 2. Frequency of responses to the SDCC-related student reaction questionnaire (n=29).

	Contributed less	Contributed as much as	Contributed more
The SDCC activities compared to the traditional classes	1 (3.5%)	10 (34,5%)	18 (62%)
The SDCC activities compared to HFS activities	10 (34,5%)	16 (55,2%)	3 (10,3%)
	I would like less	**Adequate**	**I would like more**
Were the number of topics addressed during the module, both in the HFS and the SDCC, adequate for your training as a general practitioner?	0	17 (58,6%)	12 (41,4%)

Source: Questionnaire prepared by the research team.

On the number of topics addressed by both methods during the module, 17 students (58.6%) agreed that it was appropriate for their training as a general practitioner. In contrast, 12 (41.4%) answered that they would like to have been exposed to more topics (Table 2).

Qualitative analysis of experience with realistic simulation

After the pre-analysis with floating reading and exploration of the material from the fields for free writing, the students' reports were divided into five categories: teaching-learning process, contribution to professional training, skills, attitudes/behavior, and quality of activity from the student's point of view.

Category 1 – Learning-teaching process

About the learning-teaching process, it was evident in the students' reports the recognition of HFS as a teaching strategy that contributes to meaningful learning, which can be observed in the examples of the following excerpts:

> *"I liked the simulations and the way it was done, I had simulation experience in other disciplines, and this was the one I felt the best evolution. I felt myself in a very realistic scenario; the discussions were enriching. Staying in another room as an observer with other colleagues and being able to discuss the doubts that arose makes learning much more enriching" (Subject 16).*

> *"The simulations contributed significantly to my learning and made me acquire greater security to act in the addressed scenarios " (Subject 8)*

> *"The leap of knowledge was gigantic. My experience was essential to knowing how to deal in real life" (Subject 12)*

Another characteristic frequently mentioned by the students was integrating theory with practice, which is a great challenge for medical education.

> *"Opportunity to apply in a more practical way what is read, considering that I perceived the different dynamics between the participants" (Subject 19)*

> *"I could feel like I was in a real-life service" (Subject 14)*

> *"Integrates theoretical study with practice" (Subject 27)*

The systematization of emergency care was present in 14 of the 29 students' reports as a gain in the approach of pediatric patients after exposure to realistic simulation. The report below is an example of a student who indicated systematization as a strong point acquired during the practice of realistic simulation:

> *"I enjoyed it. It helps a lot to plan an emergency care, and this is our first contact with the area in pediatrics" (Subject 2)*

> *"This is a very productive scenario, with exponential and visible gain in specific knowledge and systematization capacity of pediatric emergency assessment" (Subject 21)*

In the spontaneous discourse of three students, realistic simulation was cited as a teaching strategy that generates motivation to study. Additionally, in the structured Likert questionnaire, we noticed that the majority (96%) responded positively to the statement that they had studied the topic after realistic simulation activity.

> *"I could see how I was progressing with the passing of the simulations, and this gave me safety and more stimulation to study" (Subject 25)*

> *"Stimulus to study after the scenarios" (Subject 23)*

In the structured questionnaire, all students agreed that the realistic simulation laboratory infrastructure and the simulator quality are adequate for the activities performed there. Regarding the role of the instructors involved in the HFS, 96% agreed that they met a constructive feedback during the debriefing, 93% stated that the professors recommended complementary reading after the simulation activity, and 100% agreed that they reinforced behavioral/attitudinal aspects. In the reports in the open fields of the questionnaire, we found discourses corroborating these estimates.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

> *"Professors are well-prepared at the time of practice and do not rush us in our conduct" (Subject 9)*

> *"Excellent equipment and infrastructure during simulation" (Subject 5)*

Regarding the relevance of the topics addressed during the HFS activity, some reports reveal the students' satisfaction with the topics, such as the following:

> *"The first contact with these topics was great. I believe they are extremely relevant to our training, and I have learned a lot" (Subject 7)*

> *"I enjoyed it. It helps a lot to plan an emergency care, and this is our first contact with the area in pediatrics. Some topics were essential for greater personal security" (Subject 2)*

The discourses on the teaching learning process are summarized below (Table 3).

Category 2 - Contribution to professional training

Regarding the contribution to professional training, it was evident in the students' discourse that realistic simulation provided professional growth and students' self-confidence in the practice of pediatric emergencies. (Table 4)

> *"I felt like I was taking another step in my training as a future general practitioner. With a little more security to deal with pediatric patients, but of course, there is still plenty of room to grow" (Subject 14)*

Of the 29 students, nine inferred that realistic simulation positively impacted their professional growth, and eight reported increased confidence to act as physicians in pediatric emergencies. In the structured questionnaire, 26 (89.7%) strongly agreed that realistic simulation would help them work more safely in the face of pediatric emergencies.

Table 3. Teaching learning process: thematic units, number of citations, and examples.

Thematic units	Number of citations	Examples
Meaningful learning	13	"The simulations contributed significantly to my learning and made me acquire greater security to act in the addressed scenarios "
Practical theory integration - applicability	11	"It was a very good experience, and I was able to put into practice subjects discussed in theory."
Systematization of care	14	"The ABCDE method has been well developed and assimilated. We learn to act quickly when necessary"
Motivation to study	3	"I could see how much progress was made as the simulations passed, and this gave me safety and more stimulation to study."
Infrastructure	1	"Excellent equipment and infrastructure during simulation" "I felt like I was in a very real-life scenario."
Teachers' qualification	1	"The teachers are well-prepared at practice time and do not rush us in our conducts"
Relevant topics	5	"The first contact with these topics was great. I believe they are extremely relevant to our training, and I have learned a lot."

Source: Questionnaire prepared by the research team.

Table 4. Contribution to professional training: thematic units, number of citations, and examples.

Thematic units	Number of citations	Examples
Self confidence	9	"The simulations contributed significantly to my learning and made me acquire greater security to act in the addressed scenarios "
Professional growth	9	"I felt myself taking another step in my training as a future general practitioner."
Patient safety	2	"Opportunity to make mistakes without effectively harming someone's life."
Important for training	2	"Very important for my training; I believe I am more prepared for medical practice after passing through this scenario."

Source: Questionnaire prepared by the research team.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

Category 3 – Skills, Attitude and Behavior

When we performed floating reading and explored the material of the open fields of answers to the questionnaires, we observed some citations about the positive effect of the HFS on skills, behavior and attitude. Among the 29 participants, 12 addressed improvements in attitude and behavior, such as communication and teamwork. The participants reported:

> *"Knowing how to define the priorities in care, therapeutic approaches, improvement behavior and also resolution in the face of critical pediatric patients" (Subject 10)*
>
> *"Tranquility, posture when communicating with the family member and evaluating ABCDE" (Subject 11)*
>
> *"I could notice a great evolution of learning and even posture with each activity" (Subject 17)*
>
> *"Discussion on posture and behavior" (Subject 16)*
>
> *"Tranquility, posture when communicating with the family member" (Subject 11)*

Category 4 - Quality of activity

Student satisfaction was notorious in the open field responses, with no adverse reports about the method (Table 5). These reports follow the same perception in the Likert-type answers to the structured questionnaire, in which 76% of the students classified the experience as excellent and 24% as good.

> *"It was the best scenario of the module, in my opinion, and one of the coolest experiences throughout the period. I could see how much I progressed with the passing of the simulations, and this gave me security and more stimulation to study" (Subject 25)*

DISCUSSION

The medical students participating in this study showed that realistic simulation activities positively contributed to their training as general practitioners and their safer performance in pediatric emergencies. Most students considered the experience to be optimal and stated that the association of HFS with SDCC is the best way to approach pediatric emergency issues.

The key element in clinical teaching is the patient. Simulated patients, patient manikins, and virtual patients have been increasingly used in medical training to complement the students' experiences with actual patients. Currently, simulation is an essential element and not optional in the curriculum for medical graduation. It is a teaching strategy that encompasses not only technical skills but also crisis management, leadership, teamwork, and clinical reasoning that do not involve harm to the actual patient. The implementation of a simulation-based curriculum within a pediatrics internship can result in higher knowledge scores and lead to improvements in medical student clinical performance during the internship[18].

It is noteworthy that the results captured by this questionnaire comprised the student's perception of the effects of realistic simulation and were supported by the learning premises on which this methodology is based. One of the axes of the Realistic Simulation highlighted by the participants of this study was the integration between theory and practice. Linking theory to practice is a vital goal for students. Active methodologies, such as simulation, have improved the students' ability to think critically, synthesize content, and practice simple and complex skills in safe environments[19].

Many students reported that the opportunity to learn and practice the systematization of pediatric emergency care was

Table 5. Quality of activity**:** thematic units, number of citations, and examples**.**

Quality of Activity	Number of citations	Examples
Very good	11	"Very good and efficient learning experience"
Excellent	4	"The experience I had was very good, both acting as a doctor in the simulation activities and participation in the debriefing discussions. I learned to plan in my mind a more targeted examination and early intervention. I loved the experience"
Best Scenario	1	"It was the best scenario of the module, in my opinion, and one of the coolest experiences throughout the period. I could see how I was progressing with the passing of the simulations, and this gave me security and more stimulation to study."
Productive	4	"This is a very productive scenario, with exponential and visible gain in specific knowledge and systematization capacity of pediatric emergency assessment."
Interesting	1	"I found it very interesting; I learned a lot."
Valid	1	"The leap of knowledge was gigantic. My experience was essential to know how to deal in real life scenarios."

Source: Questionnaire prepared by the research team.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

one of the highlights of the simulation practice. This is relevant information because according to the Guideline of the American Heart Association, widely used in pediatric emergency care, the initial approach of the patient in the emergency room should be systematized following updated protocols. Thus, teaching pediatric emergency care systematization during undergraduate school may represent the difference between life and death for an infant or child with a life-threatening condition[20].

Professional growth, skills acquisition, and self-confidence improvement mentioned by most students are objectives of realistic simulation. Self-confidence is the person's perception of their ability to accomplish something, that is, people's belief in organizing and executing courses of action to achieve a particular result. People mobilize cognitive, affective, and behavioral aspects for a given action if they believe they can perform it. Adverse or discouraging reactions can eliminate the belief in self-efficacy[21]. According to Coolen, 2010, an interactive pediatric program in recognizing and managing critically-ill children positively affects self-confidence for resuscitation skills in children and adults[22].

The students' answers also showed increased motivation to study after experiencing simulated scenarios. These data are I line with literature references that simulation can lead to student engagement and motivation, as students often feel challenged and encouraged, know their limits, and seek improvements[13].

Infrastructure and professional training are key points for success in the teaching-learning process. These become even more important in HFS since it is a teaching technique with associated technology[23.] The students' positive opinion on these two aspects was evident, both in the Likert-type responses and in the open-field responses. The pedagogical objectives of the realistic simulation in the pediatric internship are based on the formation of the general practitioner, so all the topics were carefully chosen for this purpose. As shown earlier, all students confirmed that the addressed topics were relevant to their training as general practitioners. Regarding improving skills such as attitude and behavior, the students' reports say they meet what is desired for the formation of a general practitioner. In 1990, George Miller developed the Miller Pyramid, which consists of four levels: the lowest level corresponds to knowledge (knowing), followed by competence (knowing how), performance (show how), and action (doing). In 2016, Cruess and Steinert proposed a fifth level in the pyramid, which incorporated professional values and attitudes toward the student. This proposed fifth level reflects the presence of a professional identity, who these future doctors are, how they act, and their values and attitudes; the fifth level is called "BEING"[24]. Interestingly, undergraduate students perceive in their training the importance of "being" and identify the realistic simulation method as a tool for developing these skills.

Among the reports obtained during the study, some students talked about learning about working as a team, a fundamental attribute for the medical professional. Simulation can address not only the acquisition of individual technical skills but also train the student to work as a team in a coordinated and effective manner[25].

In this study, most students believed that the association of the two active methodologies (HFS and SDCC) would be ideal for addressing pediatric emergency issues during pediatric internship. This opinion coincides with the current trend of hybrid curricula that offer multiple educational methods and strategies. This model applies the principles of Andragogy, defined by Malcolm Knowles as art and science, to help adults learn[26].

Finally, the students who participated in this study reported high satisfaction with realistic simulation activities, which directly reflects their performance. In a study conducted by Seneviratne *et al.*, 2020, medical students mentioned that HFS should be used more often in teaching therapeutics. They further mentioned that it is better than small group discussions[27]. Studies show that high-fidelity simulations increase student satisfaction in intensive care or medical-surgical clinic learning skills[28,29].

The COVID-19 pandemic made this study almost unfeasible since initially we had activities suspended due to the lockdown and consequently, the study was temporarily suspended. At the resumption of activities, still during the pandemic, the groups designated to participate in high-fidelity realistic simulation activities were smaller, in order to comply with the safety and distancing standards imposed by the pandemic, limiting the size of the study participant population and almost preventing the continuity of the study.

This study has limitations. The main one, imposed by the COVID-19 pandemic, was the sample size. The plan was to include the 120 students who would rotate in the pediatric emergency course during 2020. However, the institution's activities were suspended at the end of March and only returned in the second semester with a major limitation on the number of students per activity. Another limitation was the study location, a single educational institution with a specific physical structure and human resources, limiting the generalization of the results to other institutions with different characteristics. Furthermore, this study evaluated only the self-reported perception of the students but not the perception of the teacher, which can be considered a perception bias. However, the anonymization of the students may have minimized this bias. Future research should explore the perception of the teachers and preceptors.

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

Despite these limitations, the results of this study corroborated our empirical perception that HSF in pediatrics is necessary to improve the technical and non-technical skills of undergraduate medical students.

CONCLUSIONS

This study showed a positive perception of undergraduate students regarding the use of High-Fidelity Simulation as a teaching methodology. Knowing the students' reactions to teaching activities helps teachers guide their future actions. Just as the feedback from teachers to students during the debriefing phase of realistic simulation is considered a vital element of the teaching-learning process, the assessment of student reaction to teaching activities is feedback to teachers about their practice, providing support for the improvement of the used methods.

ACKNOWLEDGMENTS

We wish to thank the students who participated in simulation activities and gave their time and views willingly and gratefully.

AUTHORS' CONTRIBUTION

Nathalia Veiga Moliterno participated in the conception and design of the study, carried out the data acquisition, participated in the analysis and interpretation of data, and drafted the manuscript. Eneida Quadrio de Oliveira Veiga participated in the data acquisition, analysis and interpretation of the data. Patrícia Zen Tempski participated in analysis and interpretation of the data. Antônio José Ledo Alves da Cunha, Arnaldo Prata-Barbosa, and Maria Clara de Magalhães-Barbosa participated in the conception, design, and analysis of the study. All authors critically reviewed the manuscript and approved the final version.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests to declare.

SOURCES OF FUNDING

This research was funded by grants from the Department of Pediatrics of the D'Or Institute for Research & Education (IDOR) and from the Department of Pediatrics of the Faculty of Medicine, UNIFASE, RJ, Brazil. The funding sources did not influence the study design, data acquisition or interpretation, or manuscript writing. Its role was only to provide the logistical resources for the operation of the research group without interfering with the design or results of the study.

REFERENCES

1. Allan CK, Thiagarajan RR, Weinstock PH. Simulation training in pediatric critical care medicine. Pediatric Critical Care Medicine.2014(1):157–166.
2. Ojha R, Liu A, Rai D, Nanan R. Review of Simulation in Pediatrics: The Evolution of a Revolution. Front Pediatr.2015 Nov 30;3:106.
3. Trainor JL, Krug SE. The Training of Pediatric Residents in the Care of Acutely Ill and Injured Children. Arch Pediatr Adolesc Med. 2000;154:1154-1159
4. Couto TB, Farhat SCL, Geis GL Olsen O, Schwartzman C. High-fidelity simulation versus case-based discussion for teaching medical students in Brazil about pediatric emergencies. Clinics.2015; 70(6), 393–399. https://doi.org/10.6061/clinics/2015(06)02
5. Grant VJ, Wolff M, Adler M. The Past, Present, and Future of Simulation-based Education for Pediatric Emergency Medicine. Clin Pediatric Emerg Med.2016; 17(3):159–68.
6. Lewis R, Strachan A, Smith MM. Is High Fidelity Simulation the Most Effective Method for the Development of Non-Technical Skills in Nursing? A Review of the Current Evidence. The Open Nursing Journal. 2012;6:82
7. Lubbers J, Rossman C. Satisfaction and self-confidence with nursing clinical simulation: Novice learners, medium-fidelity, and community settings. Nurse Educ Today. 2017;48:140–4. http://dx.doi.org/10.1016/j.nedt.2016.10.010
8. Cant RP, Cooper SJ. Simulation-based learning in nurse education: Systematic review. Vol. 66, Journal of Advanced Nursing. 2010;3–15.
9. Cheng A, Duff J, Grant E, Kissoon N, Grant VJ. Simulation in paediatrics: An educational revolution. Paediatr Child Health. 2007;12(6):465–8.
10. Dieckmann P, Friis SM, Lippert A, Ostergaard D. The art and science of debriefing in simulation: Ideal and practice. Med Teach. 2009;31(7).
11. Weller JM, Nestel D, Marshall SD, Brooks PM, Conn JJ. Simulation in clinical teaching and learning. Medical Journal of Australia. 2012;196(9):1–5.
12. Borges MC, Miranda CH, Santana RC, Bollela VR. Avaliação Formativa e aprendizado na saúde. Medicina (Ribeirão Preto) 2014;47(3):324-31 http://revista.fmrp.usp.br/
13. Harden RM, Laidlaw JM. Essential Skills for a Medical Teacher: An Introduction to Teaching and Learning in Medicine. 3nd edition. Saint Louis: Elsevier; 2021. 317 p.
14. Metz J, Stone K, Reid J, Burns R. Pediatric Boot Camp Series: Infant With Altered Mental Status and Seizure - A Case of Child Abuse. 2017 https://doi.org/10.15766/mep_2374
15. Metz J, Burns R. Pediatric Boot Camp Series: Longitudinal Care for a Child with Asthma-From the Emergency Department to Outpatient Clinic. MedEdPORTAL. 2020 May 29; 16:10906.
16. Paiva JHHGL, Barros LCM, Cunha SF, Andrade TH de S, Castro DB de. O Uso da Estratégia Gameficação na Educação Médica. Rev Bras Educ Med. 2019 Mar;43(1):147–56.
17. Bardin L. Análise de conteúdo. Edition 70, 1977. ISBN: 972-44-0898-1
18. Dudas RA, Colbert-Getz JM, Balighian E, Cooke D, Golden WC, Khan S, et al. Evaluation of a simulation-based pediatric clinical skills curriculum for medical students. Simulation in Healthcare. 2014 Feb;9(1):21–32.
19. Khalaila R. The relationship between academic self-concept, intrinsic motivation, test anxiety, and academic achievement among nursing students: Mediating and moderating effects. Nurse Educ Today. 2015 Mar 1;35(3):432–8.
20. Disque K. PALS-Pediatric Advanced Life Support Provider Handbook PALS 2020-2025 Guidelines and Standards 2 PALS-Pediatric Advanced Life Support. 2021.
21. Bandura A. Self-efficacy: Toward a Unifying Theory of Behavioral Change. Vol. 84, Psychological Review. 1977.
22. Coolen EHAJ, Loeffen JL, Draaisma JMT. Enhancing self-efficacy for paediatric resuscitation skills in the undergraduate medical curriculum. Vol. 81, Resuscitation. 2010. p. 131–2.
23. Gaba DM. The future vision of simulation in health care. Qual Saf Health Care. 2004;13(1):2–10. Available from: www.qshc.com

DOI: https://doi.org/10.1590/1981-5271v48.1-2022-0392.ING

24. Cruess RL, Cruess SR, Steinert Y. Amending Miller's Pyramid to Include Professional Identity Formation. Vol. 91, Academic Medicine. Lippincott Williams and Wilkins; 2016.180–5.

25. Stewart M, Kennedy N. Undergraduate interprofessional education using high-fidelity paediatric simulation. Clinical Teacher. 2010. 90-96, 7(2) https://doi.org/10.1111/j.1743-498X.2010.00351.x

26. Knowles MS, Holton EF, Swanson RA. The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development. 2005.

27. Seneviratne T, Somaratne K, Alahakoon V, Bandara D, Bandara D. Teaching therapeutics in paediatrics using high fidelity simulation: Knowledge gain and perception among final year medical students. Sri Lanka Journal of Child Health. 2020;49(1):59–63.

28. Abdo A, Ravert P. Student Satisfaction with Simulation Experiences. Clin Simul Nurs. 2006;2(1).

29. Liaw SY, Koh Y, Dawood R, Kowitlawakul Y, Zhou W, Lau ST. Easing student transition to graduate nurse: A SIMulated Professional Learning Environment (SIMPLE) for final year student nurses. Nurse Educ Today. 2014 Mar 1;34(3):349–55.