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EFFECTIVENESS AND PERSPECTIVES OF SIMULATION TECHNOLOGIES IN EDUCATION OF STUDENTS FROM HEALTH SPECIALTIES

THESIS SUMMARY

for awarding a **PhD** degree

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Varna, 2023

The dissertation work has been approved and proposed for defense at an extended meeting of the Department of Social Medicine and Health Care Organization at the Medical University "Prof. Dr. Paraskev Stoyanov".

The dissertation is written on 18 9 pages and illustrated with 16 tables, 6 figures and 8 appendices.

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The public defense of the dissertation work will take place on September 26, 2023. from 2 p.m. at Varna Medical University.

CONTENTS

LIST OF ABBREVIATIONS

AEO	English language training
BEO	Bulgarian language training
vit.	vitamin
incl.	inclusive
Mr.	year, years
city.	city
m.	month
e.g.	for example
WHO	World Health Organization
ST	simulation technologies
assistant _	co-authors
USD _	US dollars
et al.	et alierte , and collaborators
IQR	Interquartile range
min	minutes
mm	millimeters
sec.	seconds

INTRODUCTION

Modern medical education is associated with many and serious challenges for both lecturers and students and interns. The long history of simulation-based medical education has gone through various stages and is associated with the introduction of simulation mannequins and models, anatomical models, standardized patients, various computerized simulators (via augmented reality and interactive virtual simulation) and 3D printing. Simulation training in surgery dates back to about 2,500 years ago, and in pediatrics and obstetrics - from the 18th century. In the 20th century and especially in the current century, the application of simulation technologies in various medical disciplines is much more intensive and widespread. This is due both to the rapid development of these modern technologies and to the undoubted advantages of the used methods and forms of simulation of the training of students and doctors - high quality, significant efficiency, economy, reliability and safety for the patient himself.

The results of the systematic review of the foreign literature published in the last few years highlight both a number of significant scientific achievements and some insufficiently clarified practical issues in this specific field. The literature review made on this topic for Bulgaria shows individual articles and reports from conferences by Bulgarian authors. This motivated us to conduct the present in-depth study to investigate the opinions of medical and dental students and their lecturers regarding the results of the effective application of modern simulation technologies in the course of training at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna.

GOAL, TASKS AND WORKING HYPOTHESES

The purpose of the dissertation is to analyze the application, effectiveness and prospects of simulation technologies in the education of students of health specialties.

To achieve this goal, the following tasks are set:

1. To make a historical review of the introduction and application of simulation technologies in the preparation of students of health specialties;
2. To study the different types of simulation technologies, the trends in their modern development and the goals of their application, incl. in Bulgaria;
3. To determine the effectiveness of the application of simulation technologies compared to classical teaching methods;
4. To evaluate the subjective experience, attitude and experience of students and lecturers when working with simulation technologies in the course of training and the evaluation process;
5. To identify the barriers to the widespread introduction of simulation technologies in the training of health professionals.

Formulated working hypotheses:

1. The application of simulation technologies is more effective than classical teaching and assessment methods.
2. Students and lecturers are well informed about the advantages of simulation-based learning and are ready to actively participate in the application of simulation technologies.
3. There are barriers of multidisciplinary origin for the wide introduction of simulation technologies in the education of students of health specialties.

METHODOLOGY

The following methods have been applied to fulfill the tasks and test the working hypotheses:

1. Documentary method in carrying out the historical review of the available and accessible scientific literature on the creation, introduction and application of simulation technologies (ST) in the training of health professionals; study of different types of ST, the trends in their modern development and the purposes of their application; analysis of the regulatory framework for regulating the application of ST.

2. A survey to investigate the attitudes and experience of students from the specialties "Medicine" and "Dental Medicine" in the mentioned two forms of education - BEO and AEO (training in Bulgarian and English language), at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna . The survey was conducted during the summer semester of the academic year 2020/2021. The questionnaire for students consists of 11 structured, semi-structured and open-ended questions, with options for free answers according to the following types: socio-demographic, insurance, experience and opportunities to work with simulators . The questionnaire was pilot tested among 10 students and after three of the questions were revised, it was distributed to the target groups: 200 fifth-year medical students and 100 third-year dental students course. The choice of the course is determined by the inclusion of simulation technologies in the practical training of the students in the specified specialties. The questionnaires were distributed by the researcher at the end of the semester. The returned completed questionnaires are 186 from the specialty "Medicine" (101 - BEO and 85 - AEO) and 73 from the specialty "Dental Medicine" (47 - BEO and 26 - AEO).

3. Experimental study - to evaluate the effectiveness of training with the maternal- fetal simulator CAE Fidelis ™ Lucina in students of the specialty "Medicine" in the fourth year in their training in childbirth and the first care of the newborn. A comparison was made of the knowledge about ST, the experiences of using ST, the experience and the success rate of the 4th year students in performing the task with real patients between two groups: control - with theoretical training and without prior training on a birth simulator and experimental - with theoretical training and pre-task performance on real patients, simulator training. The study was carried out in the educational base of the Varna Medical University - SBAGAL "Prof. Dr. Stamatov" during the summer semester of the academic year 2021/22 during the practical classes on the relevant topic in the course of training in the discipline "Obstetrics and Gynecology". 137 medical students from 12 student groups (randomly

randomized 65 each for the control and experimental groups) led by six professors from the discipline of Obstetrics and Gynecology were invited to participate in the study.

The experiences and perceptions that the students have during the performance of the task were studied in the case of students from both groups; the role of the lecturer; knowledge about the types and advantages of simulation technologies through the application of a direct individual questionnaire. The students in the experimental group completed the knowledge and experience questionnaire after an initial instructor-led training on the CAE Fidelis ™ Lucina maternal- fetal simulator and a subsequent self-performed task on the simulator for leading childbirth and first care of the newborn within four teaching hours.

During the performance of the task on the CAE Fidelis ™ Lucina maternal- fetal simulator, the lecturers evaluated the students according to the following parameters: orientation of the students in the anatomical features of the simulator; performing a review; evaluation of the student's actions in monitoring the birth process; evaluation of the student's actions in monitoring the reactions of the mother in labor and the adequacy of the behavior; performing, if necessary, instrumental support of childbirth (vacuum, forceps); assessment of the student's actions during delivery of the placenta; APGAR score recording from the simulator.

The students of the experimental group completed the task on real patients during the lessons after the initial training. In case of impossibility to carry out the task during the practical session of the program due to lack of a suitable patient (mother in the second phase of labor), the students performed the task at an additional time.

After completing the task on real patients, students in the control group completed a short questionnaire including questions about the benefits, experience of use, and the role of ST in education.

During the performance of the task on real patients in both groups of participants (experimental and control), the lecturers again monitored and evaluated the students according to the following parameters, according to the observation protocol:

- ✓ orientation of students in anatomical features;
- ✓ performing an examination;
- ✓ evaluation of the student's actions in monitoring the birth process;
- ✓ evaluation of the student's actions, tracking the reactions of the mother in labor and the adequacy of the behavior;

- ✓ performing, if necessary, instrumental support of childbirth (vacuum, forceps);
- ✓ evaluation of the student's actions during the delivery of the placenta;
- ✓ evaluation of the student's actions in performing first care for the newborn with calculation of the APGAR score .

The evaluation of students' success rate is on a 5-point scale: 1 – very bad; 2 – bad; 3 – average; 4 – good and 5 – very good.

The APGAR score was applied to evaluate the adaptation of the newborn immediately after birth - at the 1st minute to assess the vital functions of the newborn, the need to carry out resuscitation measures and as a result of successful/unsuccessful management of the birth process. The scale consists of 5 indicators (muscle tone, heart rate, response to irritation, skin color, breathing), which are evaluated from 0 to 2 points and finally summed up:

1. Muscle tone - with free movement of the limbs, the score is 2 points; for weak movements (for example: slight flexion) – 1 point; in the absence of any movements – 0.
2. Heart rate - if the pulse is over 100 beats/min, the score is 2 points, if it is below 100 beats/min - 1 point, if there is no pulse - 0 points.
3. Breathing - with normal frequency and rhythm of breathing, loud crying - 2 points, with slow and uneven breathing and weak crying - 1 point and with no breathing - 0 points.
4. Irritation/aspiration reaction - recoil, sneezing, coughing, crying - 2 points; if there is only a facial expression - 1 point, and if there is no reaction - 0.
5. Skin color - if the whole body is pink (including the limbs) - 2 points; if the limbs are grayish - 1 point, and if the whole body is bluish - 0 points.
6. Breathing - with normal frequency and rhythm of breathing, loud crying - 2 points, with slow and uneven breathing and weak crying - 1 point and with no breathing - 0 points.

The result of the sum of the points of the five indicators is from 0 to 10 points, which are interpreted as follows:

7-10 points – normal adaptation of the newborn without the need for intensive care and treatment;

4-6 points - moderately severe depressive state of the newborn with the need for primary resuscitation to support adaptation, for example, mechanical stimulation of breathing, oxygen supply, providing thermal comfort, etc.

≤ 3 points – severe depressive state of the newborn with the need for intensive care and treatment, incl. apparatus ventilation, etc.

The APGAR score assessment was performed by the lecturer in the real patients and by the simulator, as a set function during the performance of the task. The description of the technical characteristics of the maternal- fetal simulator CAE Fidelis ™ Lucina used for the experimental study is presented in the corresponding appendix.

4. Survey among AG lecturers. The study among the teaching staff of the Department of Obstetrics and Gynecology at the Medical University "Prof. Dr. P. Stoyanov" - Varna was held to establish the knowledge, attitudes and subjective experience of applying simulation technologies in the training of students from various health and medical specialties in the discipline "Obstetrics and Gynecology".

The research toolkit is a direct individual survey card, including 16 questions (8 – open; 6 – closed and 2 – semi-open), distributed in 4 thematic areas:

- knowledge about the types and advantages of ST for the education of students;
- training, previous experience and experiences of the application of ST in the education of students;
- assessment of students' work with ST;
- demographic indicators.

The time of conducting the research is the end of the summer semester of the 2021/2022 academic year.

5. Qualitative method for expert assessment of barriers and perspectives of ST in education among representatives of various institutions and units related to the development, introduction and implementation of ST in medical educational institutions:

- ✓ Managers and experts from the simulation centers at the Ministry of Education in Bulgaria;
- ✓ Representatives of companies, manufacturers of simulation technologies;
- ✓ Bioethics experts in the field of ethical aspects of simulation technologies and robotics in medicine;
- ✓ Lawyer with practice in the field of health education regulation;
- ✓ Financial expert from a higher medical school.

17 experts from two medical universities in Bulgaria, two representatives of companies producing equipment for simulation training (experts 1. and 2.), two directors of a simulation center (experts 3. and 4.) were

invited and accepted to participate in the study. , an engineer from a simulation center (expert 5), 10 professors in the disciplines of obstetrics and gynecology (experts 6 and 7), anesthesiology and resuscitation (experts 8, 9 and 10), surgery (experts 11, 12 and 13.), medical ethics and deontology (experts 14. and 15.), lawyer (expert 16.) and accountant (expert 17.). These experts can be tentatively grouped into three groups: 1) manufacturers of simulation technologies; 2) administrative managers and simulation technology provision and support staff and 3) educators using simulation technologies. Part of the administrative staff also participates in the third group due to their involvement in the teaching activities of the simulation centers they manage.

The topics set for discussion are as follows:

- ✓ Are there regulatory barriers and what needs to be done to overcome them?
- ✓ Ethical aspects in training health professionals with ST;
- ✓ National and local strategies for the development of ST in education;
- ✓ Economic justification.

To conduct the expert analysis, a questionnaire was compiled, including 11 open questions regarding the advantages, barriers and perspectives in the use of ST in the education of students of medical specialties (. The questionnaire was provided to the participants by e-mail. The principle of anonymity in the provision of answers and analysis was respected.

Study period – October 2022 – March 2023

6. Statistical methods.

6.1. Descriptive methods

- ✓ Frequency analysis of qualitative variables (nominal and ordinal) – calculation of absolute and relative frequencies (%) with presentation of the results in tabular form;
- ✓ Variance analysis of quantitative variables - calculation of mean value (arithmetic mean, median), standard deviation, standard error of the arithmetic mean at a confidence interval of 95%;
- ✓ A graphical method of displaying the results.

6.2. Hypothesis testing methods

- ✓ Parametric methods - Student 's *t* -test - for comparing arithmetic mean values from two independent samples
- ✓ Nonparametric methods

Pearson 's χ^2 test – for analysis of categorical variables; Kolmogorov – Smirnov method (Kolmogorov – Smirnov) – for checking the normality of the distribution of a quantitative variable

- ✓ Correlation analysis – to establish relationships between quantitative and qualitative variables.

The level of significance of the null hypothesis is accepted at the value α=0.05. The statistical software package SPSS v was used to enter and analyze the collected data. 25.0.

Permission was received from the Research Ethics Committee (KENI) (Decision No. 98/26.11.2020) to conduct the research.

7. Simulators. At the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, various simulators are used for the purposes of practical training of students of medicine and dentistry, young doctors and students of the specialties "Nurse" and "Midwife".

Fetal simulator CAE Fidelis ™ Lucina (Fig. 1) was evaluated with the application of the functions related to performing the external palpation by means of Leopold 's techniques , vaginal examination and labor guidance. The technical characteristics of the simulator are presented in the corresponding description of the manufacturer .

Fig.1. CAE Lucina – maternal- fetal birth simulator. Training platform for the entire birth process, incl. various complications and their correct management.

RESULTS AND DISCUSSION

1. Study of the attitudes and experience of the application of ST in the education of the students of the specialties "Medicine" and "Dental Medicine"

The analysis of the data from the questionnaires filled out by a total of 258 students, 186 in medicine and 46 in dentistry, about their attitudes and experiences with the application of simulation technologies, shows that almost all surveyed students (n=233; 90.31%) respond positively to the question "*Does every student have the opportunity to work with a simulator during the simulation-based exercise*?". This proportion is highest among medical students in AEO (n=81; 95.29%), and lowest - in dental medicine students - also in AEO (n=38; 82.61%) (Table 1).

No statistically significant relationship was found between the type of training (BEO/AEO) and the opinion regarding the possibility for each student to work with a simulator during an exercise, both for students from the medical specialty (χ^2 =2.38; p=0.12) and from the dental specialty medicine (χ^2 =1.31; p=0.25).

More than half of the surveyed students believe that there is a need to provide additional simulators in order to increase the accessibility of simulation training (n=147; 57%), and among the students of the specialty "Dental Medicine" in BEO, this share is the highest high (n=17; 63.0%). 17% of the respondents do not know if there is such a need, which is mainly due to the students of dental medicine in BEO (25.5%) (Table 2).

No statistically significant relationship was found between the type of training (BEO/AEO) and the opinion regarding the need for additional simulators both for the students of the specialty "Medicine" (χ^2 =2.72; p=0.26) and of the specialty "Dental Medicine" (χ^2 =2.89; p=0.87).

Table 1. Comparative analysis of the students' opinion about the possibility of each student to work with a simulator during a simulation-based practical session according to the type of training (BEO/AEO).

Specialty				Training		Total
				BEO	AEO	
Medicine	Does every student have the opportunity to work with a simulator?	Yes	Number	90	81	171
			% is there a possibility	52.6	47.4	100
			% by training	89.1	95.3	91.9
		No	Number	11	4	15
			% is there a possibility	73.3	26.7	100
			% by training	10.9	4.7	8.1
	Total		Number	101	85	186
			% is there a possibility	54.3	45.7	100
			% by training	100	100	100
Dental Medicine	Does every student have the opportunity to work with a simulator?	Yes	Number	38	24	62
			% is there a possibility	61.3	38.7	100
			% by training	82.6	92.3	86.1
		No	Number	8	2	10
			% possibility	80.0	20.0	100
			% by training	17.4	7.7	13.9
	Total		Number	46	26	72
			% possibility	63.9	36.1	100
			% by training	100	100	100
Total	Does every student have the opportunity to work with a simulator?	Yes	Number	128	105	233
			% possibility	54.9	45.1	100
			% by training	87.1	94.6	90.3
		No	Number	19	6	25
			% possibility	76.0	24.0	100
			% by training	12.9	5.4	9.7
	Total		Number	147	111	258
			% possibility	57.0	43.0	100
			% by training	100	100	100

Table 2. In your opinion, is there a need to provide additional simulators to increase accessibility to simulation training?

Specialty				Training		Total
				BEO	AEO	
Medicine	Is there a need to provide additional simulators to increase accessibility to simulation training?	Yes	Number	62	58	120
			% as necessary	51.7	48.3	100
			% by training	61.4	68.2	64.5
		No	Number	21	19	40
			% as necessary	52.5	47.5	100
			% by training	20.8	22.4	21.5
		I do not know	Number	18	8	26
			% as necessary	69.2	30.8	100
			% by training	17.8	9.4	14.0
	Total		Number	101	85	186
			% as necessary	54.3	45.7	100
			% by training	100	100	100
Dental Medicine	Do you think there is a need to provide additional simulators to increase the accessibility of simulation training?	Yes	Number	17	10	27
			% as necessary	63.0	37.0	100
			% by training	36.2	40.0	37.5
		No	Number	18	10	28
			% by necessity of additional simulators?	64.3	35.7	100
			% by training	38.3	40.0	38.9
		I do not know	Number	12	5	17
			% by necessity of?	70.6	29.4	100
			% by training	25.5	20.0	23.6
	Total		Number	47	25	72
			% by necessity of?	65.3	34.7	100
			% by training	100	100	100
Total	Is there a need to provide additional simulators?	Yes	Number	79	68	147
			% by necessity?	53.7	46.3	100
			% by training	53.4	61.8	57.0
		No	Number	39	29	68
			% by necessity?	57.4	42.6	100
			% by training	26.4	26.4	26.4
		I do not know	Number	30	13	43
			% by necessity?	69.8	30.2	100
			% by training	20.3	11.8	16.7
	Total		Number	148	110	258
			% by necessity?	57.4	42.6	100
			% by training	100	100	100

A positive moderate statistically significant correlation was found between the opinion regarding the need for additional simulators and the type of specialty (r=0.22; p<0.0001). There is a stronger correlation with the type of major for AEO students (r=0.233; p=0.01).

More than half of students (n=138; 54.5%) express the opinion that seminar classes with the inclusion of ST are not sufficiently represented in their education. Participants in the specialty "Medicine" (n=58; 57.43%), as well as future dental doctors (n=23; 62.16%), studying in BEO, are more critical about providing the opportunity for practical training with ST, compared with the learners of the alternative language in the same specialty (Table 3). Simulation training requires a lot of manpower and one of the main problems with the organization of training is the difficulty in accommodating a large number of students given the limited number of simulators and limited training time. No statistically significant relationship was found between the type of training (BEO/AEO) and the opinion about a sufficient number of exercises with simulators of both medical (χ^2 =0.47; p=0.79) and dental students (χ^2 =2.93; p=0.23). A positive moderate statistically significant correlation (r=0.27; p<0.0001), as well as a higher one in the AEO group (r=0.4; p< 0.0001).

Students in our study shared a very high degree of satisfaction with recreating various clinical conditions when using the simulators during their training (n=234; 91.1%). Medical students (96.8%) indicated more often that simulation technologies recreated different clinical conditions than dental students (76.4%) (Table 4). The type of specialty in which the students are trained and their opinion about recreating different clinical conditions have a positive moderate statistically significant correlation (r=0.32; p<0.0001), which is higher for BEO students (r=0.4; p<0.0001). p<0.0001), compared to those on AEO (r=0.29; p=0.002).

The results published in the foreign scientific literature on the issues of recreating clinical conditions by simulators are mostly negative. Our results are inconsistent with some other studies that students consider standardized patients to be more realistic than simulation mannequins in terms of the ability to perform the examination and history-taking methods.

Table 3. Do you think that exercises with simulators are sufficiently represented in the curriculum?

Specialty				Training		Total
				BEO	AEO	
Medicine	Do you think that simulator exercises are sufficiently represented in the curriculum?	Yes	Number	40	36	76
			% by represented	52.6	47.4	100
			% by training	39.6	43.9	41.5
		No	Number	58	43	101
			% by represented?	57.4	42.6	100
			% by training	57.4	52.4	55.2
		I do not know	Number	3	3	6
			% by represented?	50.0	50.0	100
			% by training	3.0	3.7	3.3
	Total		Number	101	82	183
			% by represented?	55.2	44.8	100
			% by training	100	100	100
Dental Medicine	Do you think that simulator exercises are sufficiently represented in the curriculum?	Yes	Number	14	3	17
			% by represented?	82.4	17.6	100
			% by training	30.4	12.5	24.3
		No	Number	23	14	37
			% by represented?	62.2	37.8	100
			% by training	50.0	58.3	52.9
		I do not know	Number	9	7	16
			% by represented?	56.3	43.8	100
			% by training	19.6	29.2	22.9
	Total		Number	46	24	70
			% by represented?	65.7	34.3	100
			% by training	100	100	100
Total	Do you think that simulator exercises are sufficiently represented in the curriculum?	Yes	Number	54	39	93
			% by represented?	58.1	41.9	100
			% by training	36.7	36.8	36.8
		No	Number	81	57	138
			% by represented?	58.7	41.3	100
			% by training	55.1	53.8	54.5
		I do not know	Number	12	10	22
			% by represented?	54.5	45.5	100
			% by training	8.2	9.4	8.7
	Total		Number	147	106	253
			% by represented?	58.1	41.9	100
			% by training	100	100	100

Table 4. Do the simulators used in your training recreate different clinical conditions?

Specialty				Training		Total
				BEO	AEO	
Medicine	Do the simulators used in your training recreate different clinical conditions?	Yes	Number	100	79	179
			% by do they recreate	55.9	44.1	100
			% by training	99.0	94.0	96.8
		No	Number	1	5	6
			% by recreate	16.7	83.3	100
			% by training	1.0	6.0	3.2
	Total		Number	101	84	185
			% by recreate	54.6	45.4	100
			% by training	100	100	100
Dental Medicine	Do the simulators used in your training recreate different clinical conditions?	Yes	Number	36	19	55
			% by do they recreate	65.5	34.5	100
			% by training	78.3	73.1	76.4
		No	Number	10	7	17
			% by do they recreate	58.8	41.2	100
			% by training	21.7	26.9	23.6
	Total		Number	46	26	72
			% by recreate	63.9	36.1	100
			% by training	100	100	100
Total	Do the simulators used in your training recreate different clinical conditions?	Yes	Number	136	98	234
			% by do they recreate	58.1	41.9	100
			% by training	92.5	89.1	91.1
		No	Number	11	12	23
			% by recreate	47.8	52.2	100
			% by training	7.5	10.9	8.9
	Total		Number	147	110	257
			% by recreate	57.2	42.8	100
			% by training	100	100	100

Table 5. Does simulation-based learning help you develop different clinical skills and competencies?

Specialty				Training		Total
				BEO	AEO	
Medicine	Does simulation-based learning help you develop different clinical skills and competencies?	Yes	Number	100	83	183
			% by does it help you develop?	54.6	45.4	100
			% by training	99.0	98.8	98.9
		No	Number	1	1	2
			% by does it help you develop?	50.0	50.0	100
			% by training	1.0	1.2	1.1
	Total		Number	101	84	185
			% by does it help you develop?	54.6	45.4	100
			% by training	100	100	100
Dental Medicine	Does simulation-based learning help you develop different clinical skills and competencies?	Yes	Number	45	24	69
			% by does it help you develop?	65.2	34.8	100
			% by training	97.8	92.3	95.8
		No	Number	1	2	3
			% by does it help you develop?	33.3	66.7	100
			% by training	2.2	7.7	4.2
	Total		Number	46	26	72
			% by does it help you develop?	63.9	36.1	100
			% by training	100	100	100
Total	Does simulation-based learning help you develop different clinical skills and competencies?	Yes	Number	145	107	252
			% by does it help you develop?	57.5	42.5	100
			% by training	98.6	97.3	98.1
		No	Number	2	3	5
			% by does it help you develop?	40.0	60.0	100
			% by training	1.4	2.7	1.9
	Total		Number	147	110	257
			% by does it help you develop?	57.2	42.8	100
			% by training	100	100	100

According to Table 5, nearly 100% of our participants indicated that simulation-based training supported the development of various clinical skills and competencies. The proportion of future medical doctors who expressed agreement on this question was higher (98.9%) than that of future dental doctors (95.8%), with a positive, very weak statistically insignificant correlation (r=0.10; p=0.1). No statistically significant relationship was found between the form of training (BEO/AEO) and the opinion regarding the contribution of simulation-based training to the development of various clinical skills and competencies both for medical students (χ^2 =0.02; p=0.89) and for dentistry (χ^2 =1.75; p=0.26).

Table 6. Is there an initial briefing before working with a new, unfamiliar to you simulator?

Specialty				Training		Total
				BEO	AEO	
Medicine	Is there an initial briefing?	Yes	Number	88	76	164
			% by instruction	53.7	46.3	100
			% by training	87.1	90.5	88.6
		No	Number	13	8	21
			% by instruction	61.9	38.1	100
			% by training	12.9	9.5	11.4
	Total		Number	101	84	185
			% by instruction	54.6	45.4	100
			% by training	100	100	100
Dental Medicine	Is there an initial briefing?	Yes	Number	45	22	67
			% by instruction	67.2	32.8	100
			% by training	95.7	84.6	91.8
		No	Number	2	4	6
			% by instruction	33.3	66.7	100
			% by training	4.3	15.4	8.2
	Total		Number	47	26	73
			% by instruction	64.4	35.6	100
			% by training	100	100	100
Total	Is there an initial briefing?	Yes	Number	133	98	231
			% by instruction	57.6	42.4	100
			% by training	89.9	89.1	89.5
		No	Number	15	12	27
			% by instruction	55.6	44.4	100
			% by training	10.1	10.9	10.5
	Total		Number	148	110	258
			% by instruction	57.4	42.6	100
			% by training	100	100	100

Satisfaction is also demonstrated in the study at the Medical Simulation Training Center at the Medical University - Plovdiv, with Sandeva and team concluding that training through simulation techniques significantly improves the knowledge, skills and attitudes of the trainees (2020).

Conducting a preliminary briefing before working with a new simulator is very important to ensure the safety of work and the effectiveness of student training. 89.5% of the surveyed students (n=231) agree with conducting such an instruction. No statistically significant relationship was found between the type of training (BEO/AEO) and the conduct of initial instruction for both medical students (χ^2 =0.51; p=0.48) and dental medicine students (χ^2 =2.75; p=0.09) (Table 6).

To the question "*Do you think that the simulators used in your training could be placed in a more realistic clinical environment* ?", only half of the students answered positively (56.3%), and nearly a third - they do not know (Table 7).

No statistically significant relationship was found between the type of training (BEO/AEO) and the opinion about the need for simulators to be placed in a more realistic clinical environment among medical students (χ^2 =4.69; p=0.09) and among those in dentistry (χ^2 =1.06; p=0.59). A positive weak statistically insignificant correlation was found between the opinion about this necessity and the type of major of the students (r=0.11; p=0.08).

About 90% of all surveyed students share the opinion that the construction of a specialized simulation center would increase the effectiveness of simulation training, and this proportion is higher among medical students (91.8%) than among dental students (79.7%). No statistically significant relationship was established between the type of training (BEO/AEO) and the opinion regarding the increase in the effectiveness of simulation training as a result of the construction of a specialized simulation center among the students of medicine (χ^2 =1.43; p=0.49) and dental medicine (χ^2 =4.77; p=0.09).

A positive weak statistically significant correlation was established between the opinion on increasing the effectiveness of simulation training through the construction of a specialized simulation center and the type of major of the students (r=0.15; p=0.016). It is logical to establish a positive weak statistically significant correlation between the students' opinion about the importance of building a simulation center to increase the effectiveness of simulation training and the need to place the simulators in a more realistic clinical environment (r=0.20; p=0.002).

Table 7. Do you think that the simulators used in your training could be placed in a more realistic clinical environment?

Specialty				Training		Total
				BEO	AEO	
Medicine	Could the simulators used be placed in a more realistic clinical setting?	Yes	Number	64	46	110
			% by clinical setting	58.2	41.8	100
			% by training	65.3	54.1	60.1
		no	Number	9	17	26
			% by clinical setting	34.6	65.4	100
			% by training	9.2	20.0	14.2
		I do not know	Number	25	22	47
			% by clinical setting	53.2	46.8	100
			% by training	25.5	25.9	25.7
	Total		Number	98	85	183
			% by clinical setting	53.6	46.4	100
			% by training	100	100	100
Dental Medicine	Could the simulators used be placed in a more realistic clinical setting?	Yes	Number	23	10	33
			% by clinical setting	69.7	30.3	100
			% by training	51.1	38.5	46.5
		no	Number	8	6	14
			% by clinical setting	57.1	42.9	100
			% by training	17.8	23.1	19.7
		I do not know	Number	14	10	24
			% by clinical setting	58.3	41.7	100
			% by training	31.1	38.5	33.8
	Total		Number	45	26	71
			% by clinical setting	63.4	36.6	100
			% by training	100	100	100
Total	The simulators used could be placed in a more realistic clinical environment	Yes	Number	87	56	143
			% by clinical setting	60.8	39.2	100
			% by training	60.8	50.5	56.3
		no	Number	17	23	40
			% by clinical setting	42.5	57.5	100
			% by training	11.9	20.7	15.7
		I do not know	Number	39	32	71
			% by clinical setting	54.9	45.1	100
			% by training	27.3	28.8	28.0
	Total		Number	143	111	254
			% by clinical setting	56.3	43.7	100
			% by training	100	100	100

A statistically significant relationship was established between the type of training (BEO/AEO) and the students' opinion regarding the sufficiency in providing the number of instructors leading the simulation-based training both in the group of medical students (χ^2 =9.4; p=0.009) and in the group of dental students (χ^2 =7.83; p=0.02). A positive weak statistically not significant correlation was found between the opinion of being provided with instructors leading the simulation-based training and the major of the students (r=0.08; p=0.22).

The need for two instructors during the training with simulation technologies was indicated by 79.1% (n=201) of all surveyed students. The highest need for the inclusion of a second instructor is indicated by the students in BEO in medicine (83.7%) and in dentistry (80%), while students in AEO show a lower frequency of this indicator in both specialties (respectively 76.5% and 62.7 %). No statistically significant relationship was found between the type of training (BEO/AEO) and the opinion regarding the need to work in a team with two instructors leading the simulation-based training among medical students (χ 2 =1.63; p=0.44) and among those in dentistry medicine (χ^2 =2.6; p=0.27)

The participants in the study made specific recommendations for improving simulation training, and in particular at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna. A total of 16.21% (n=41) of all surveyed students made their specific recommendations. Four of the medical students at AEO express sincere gratitude for the opportunities they receive in the course of simulation training.

The main recommendations of the medical students (BEO and AEO) related to the individual aspects of the simulation training are as follows: conducting the simulation training in smaller groups; increasing the number of practical classes with simulation technologies; increasing the number of simulators used during practical classes; increasing the number of assistants conducting practical classes with simulation technologies; increasing the number of instructors during practical sessions with simulation technologies.

The BEO students recommend having more *clinical cases presented* during the exercises, *dividing the simulator exercises* with no more than two groups at a time, *monitoring the student's independent work by an experienced doctor* to practice what has already been learned, *more practice* of the manipulations themselves, and the placement of injections and the presence of more dummies.

AEO students recommend that there should be *more time for independent work after the exercises*, for which it is necessary to ensure longer working hours of the simulation center in order to have constant access to it,

to evaluate all stages of the simulation (hazardous environment, status of the patient), *more training hours for performing manipulations* (taking blood, inserting the cannula), *involving actors in the clinical situations*, etc. Respondents indicated that some simulation training could be taught already in the first year instead of some theoretical topics in order to gain competence before entering the clinic (eg, instead of the topic of acid-base balance, the topic of parenteral nutrition should be included) .

The most frequent recommendations made by future dentists concern increasing the number of practical classes (including electives) using ST and providing more materials/tools. AEO students recommend that the explanations of the use of the simulator be projected on a screen so that it can be clearly seen by all the students in the room, as well as additional training with a lecturer, the registration for which is done through the BlackBoard e-learning platform .

2. Research among students of the specialty "Medicine" with a task in obstetrics and gynecology

To investigate the effectiveness of the application of simulation technologies in the training of students, an experimental study was implemented among medical students with the performance of the task "giving birth" with prior training of the simulator for the experimental group and without prior training of the simulator - for the control group.

The average age of the participants in the control group was 22.9±0.93 years (n=32; men – 15; women – 17), and of those in the experimental group – 23±1.46 years (n=25; men – 12; women – 13) and did not differ statistically significantly between the two groups (t =-0.22; p=0.83).

No statistically significant difference was found between the two genders in the given answers regarding the knowledge of the types of simulation technologies and the advantages of their application (p>0.05), which is why a comparative analysis by gender of the relevant studied questions was not made.

Knowledge and attitudes about the application of simulation technologies

Most participants (43.9%; n=25) are aware of what simulation technologies include and indicate above all simulators, dummies for training in obstetrics and surgery, while in the control group this proportion is significantly lower: 24.5%. None of the surveyed students majoring in "Medicine" indicated the specific elements and situations of simulation training - use of simulation models close to real ones; exercises similar to real surgical manipulations, development of the sense of touch, preparation for real practice, better intuition and approach to the task. One in four of the

experimental group defines ST as a type of artificial intelligence. Four of the control group (1 male and 3 females) indicated that they did not know the answer to the question "*What do you think the simulation technologies involve?*", and three defined it as equipment for teaching cardiopulmonary techniques. This result signals the need for additional and in-depth information to students about the types and possibilities of application of simulation technologies, as well as the organization of specialized training for both the instructors and the students themselves.

When asked, "*What do you think are the advantages of using simulation technologies*?", two students each highlighted the better preparation, acquired experience and practical skills in surgery. Attention is also paid to the patient-safe way of learning, the reduction of stress when learning the technique, the early familiarization with laparoscopic surgery, the acquisition of correct habits, the integration of new and innovative methods in medicine, the increase of work efficiency, the development of a good orientation and coordination, as well as the faster assimilation of the material and familiarization with the surgical tools.

More than half of the participants (61.4%; n=35) reported that they had experience using simulation technologies in their studies, and this frequency was statistically insignificantly higher in the control group (57.1%; n=20) compared to the experimental group group (χ^2=0.04; p=0.85) (Table 8). Only one of the participants shared that the experience with the application of simulation technologies was negative, and all the others gave an excellent or good self-assessment of the previous application of simulation technologies in their studies.

Table 8. Distribution of the participants from the two groups according to the presence of experience with the application of simulation technologies in training

			Group		Total
			Control	Experimental	
Do you have experience using simulation technologies in your training so far?	Yes	Number	20	15	35
		% by experience	57.1	42.9	100
		% by group	62.5	60.0	61.4
	no	Number	12	10	22
		% by experience	54.5	45.5	100
		% by group	37.5	40.0	38.6
Total		Number	32	25	57
		% by experience	56.1	43.9	100
		% by group	100	100	100

All participants in the control group and 95.8% (n=23) in the experimental group are of the opinion that learning through the application of simulation technologies contributes significantly to the acquisition of more knowledge, experience and security.

Conducting an experiment using initial simulation training for the birth process and first care

Lucina simulator with subsequent evaluation by the supervising lecturer of the independent performance of the simulation task of leading the birth process and providing first care to the newborn, as well as self-evaluation of the experiences and the achieved results. Only one of the 24 students in the experimental group responded that he was unable to cope with the given task, without specifying the reason for this.

Half of the students who shared their experiences (n=11) indicated that they got stuck at the beginning and needed help to start the task. 8 (36%) of the students completed the task in a calm and organized manner, and only three shared that they were in favor of the algorithm or could not find the protocol of the task.

The presence of the lecturer during the individual simulation task did not affect in any way the perceptions and the way of dealing with the task in 91.7% (n=22) of the students in the experimental group and only two (8.3%) felt more worried in the given situation.

A significant part of the participants in the experimental group (80.1%; n=20) shared that they needed guidance from the trainer during the simulation task, and 16% (n=4) could not judge.

Almost all students in the experimental group (92%; n=23) reported that the lecturers conducted the simulation training without difficulty, and only one reported feeling some uncertainty on the part of the lecturers when using the simulation technologies.

During the performance of the task of the maternal- fetal simulator *Lucina* lecturers observe and evaluate each student according to the following indicators: orientation in the anatomical features of the simulator during external palpation and gynecological examination, monitoring of the birth process, the adequacy of the behavior during the birth of the fetus, the adequacy of the behavior for the delivery of the placenta, performing, if necessary, instrumental birth support (vacuum, forceps), as well as readings of the APGAR score of the respective newborn. As expected, students with prior experience of using ST in their studies showed higher mean scores (excluding placental abruption) compared to their peers without prior experience,

although without a statistically significant difference in values (p>0.05) (Table 9).

Table 9. Comparison of students' evaluations when performing the simulator task between the groups with and without previous training experience using simulation technologies in other disciplines (ndependent Samples t- test).

How do you rate the student's actions regarding….?	Experience with ST?	Number	Mean	S D ±	SE Mean	t	p
the orientation in the anatomical features of the simulator; performing a review	Yes	15	4.80	0.42	0.1	-1.07	0.29
	No	10	4.60	0.51	0.1		
tracking the mother's reactions and the labor process?	Yes	15	5.00	0.01	0.0	-1.82	0.08
	No	10	4.73	0.46	0.2		
the adequacy of fetal birth behavior?	Yes	15	4.80	0.42	0.1	-0.37	0.72
	No	10	4.73	0.46	0.3		
the student's actions to deliver the placenta?	Yes	15	4.27	0.46	0.1	-1.18	0.25
	No	10	4.50	0.53	0.2		
perform instrumental support (vacuum, forceps) if necessary?	Yes	15	4.93	0.28	0.1	0.89	0.37
	No	10	4.80	0.42	0.1		
APGAR score	Yes	15	9.6	0.43	0.1	0.32	0.75
	No	10	9.2	0.28	0.1		

Moderate statistically significant correlation of the studied indicators was found only between APGAR score and self-assessment of the previous experience (r=-0.46; p=0.02) and the degree of coping with the task (r-0.61; p=0.002). Students who rate their experience of working with ST and their performance on the task more highly have also demonstrated higher APGAR score values

Conducting training of students on real patients on delivery management and first care of the newborn

Students from both groups of participants in the study completed the task of guiding labor in the second phase of the labor process and first care of the newborn of real patients within the framework of the organized additional hours. The results of the evaluation of the participants from both groups are presented in Table 10.

Table 10. Comparison of students' evaluations of performance of the task of leading childbirth and first care of the newborn of real patients between the experimental and control groups (Independent Samples t- test).

How do you rate the student's actions regarding….	A group of participants	Number	Mean	SD ±	t	p
performing an examination (external palpation , vaginal douching)?	control	32	4.75	0.51	-1.61	0.14
	experimental	25	4.92	0.28		
tracking the mother's reactions and the labor process?	control	32	4.69	0.5	-1.36	0.18
	experimental	25	4.83	0.37		
actions in the degeneration of the fetus?	control	32	4.56	0.5	-1.58	0.12
	experimental	25	4.76	0.55		
perform, if necessary, instrumental support of childbirth (vacuum, forceps)?	control	32	4.38	0.50	-1.18	0.25
	experimental	25	4.60	0.53		
student actions for placental abruption?	control	32	4.78	0.42	-0.96	0.34
	experimental	25	4.88	0.33		
APGAR score	control	32	9.52	0.41	-1.33	0.19
	experimental	25	9.66	0.40		

The average scores obtained for each of the set activities show higher values in the experimental group of students who have undergone previous training on the maternal- fetal simulator, compared to the participants from the control group, although without statistical significance of the difference ($p>0.05$). The highest scores were achieved when performing the examination

of the mother through external palpation and vaginal examination to assess the birth process (experimental – 4.92; control 4.75) and placental abruption (experimental – 4.88; control – 4.78). The lowest scores were given for the instrumental support of childbirth when such a need arose (vacuum, forceps), which was expected given the need for more practice and experience to master the above techniques (4.60 and 4.38 respectively). Childbirth is among the actions with lower values, again given the need to conduct more practical classes to achieve better skills in students.

3. Survey of the opinion of obstetrics and gynecology lecturers

In the present study, 65% (n=11) of the teaching staff of the Department of Obstetrics and Gynecology at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna or almost all lecturers leading practical simulation training with students and interns at the relevant academic unit. The average age of the participants was 38.4±10.2 years (27÷56 years; median 35.5 years). No statistically significant difference was found regarding the average age values for both sexes (p=0.51). Almost all lecturers (n=10) using simulation technologies in their education have less than 10 years of work experience, and only one has a longer work experience – 20 years (median length of work experience – 4 years). The average duration of experience with the application of ST in teaching practice is 2±1.1 years (1÷4 years).

To the question "*What do you think simulation technologies include?*", 11 professors of the discipline "Obstetrics and gynecology" answered that in their field it mainly concerns the management of childbirth, training, conducting experiments and scientific research, laparoscopic and other surgical interventions, and less often - for the use of exercise machines, training for performing cardiopulmonary resuscitation , for the application of obstetric techniques, treatment of complications, training and testing.

Regarding the advantages of simulation technologies, four indicated their closeness to reality and saving time and money. One lecturer at a time emphasizes some other features of simulation technologies – innovation, improved quality and practical orientation of training, as well as exercise of action protocols.

Almost all lecturers have no difficulty conducting training using simulation technologies, and only the lecturer with the longest working experience shared that he felt insufficiently prepared to teach students with the help of simulators.

Three lecturers defined their experiences during the simulation training as satisfaction and presence of interest, and one lecturer highlighted the adequacy of conducting the practical exercises.

The training that the lecturers have undergone for the application of simulation technologies in the education of students and specialists consists mainly of intensive two -three day courses (n=9). The oldest educator indicated training in a short Internet course on working with simulation technologies in childbirth and complications. One lecturer has not received specialized training in simulation technologies. The self-critical attitude towards the level of knowledge is manifested in the need for additional training in the development of simulation tasks/scenarios, the application of simulation technologies in seven of the surveyed lecturers. Next is the topic of training on the proper use of these technologies - with four lecturers. Analyzing and reporting on the completed task/simulation with the students would be the least interesting topic in attending the simulation technology application training course for six of the instructors. This is followed by student assessment (simulation assessment technologies) – for three lecturers and training on the proper use of these technologies – for two lecturers. As necessary training/support for lecturers using simulation technologies for learning and work, two lecturers each offer more courses and regular refresher courses, and one lecturer offers longer-term training and training for student assessment.

Six of the surveyed professors somewhat agree, four professors - completely agree and only the professor with the longest working experience disagrees with the introduction of the mandatory pre-diploma individual examination of the students on the simulation tasks/scenarios.

The application of individual testing of majors on simulation tasks/scenarios prior to the examination for the acquisition of a specialty is somewhat supported by two-thirds of the faculty members surveyed, two faculty members strongly agree, and again the most senior faculty member disagrees with such testing.

Respondents with less than 5 years of teaching experience (n=8) believe that learners with simulation technologies should be guided during the implementation of the simulation task. The reasons for this are the following: frequently occurring problems, difficulties in the orientation of students, the high cost of equipment, the certainty of acquiring good habits and practices. Lecturers with more than five years of experience cannot judge whether there is a need for student guidance, without giving reasons for this. Only three of the obstetrics and gynecology lecturers surveyed strongly agreed that students are prepared to give specific justifications for their actions during the task/scenario, one disagreed and the rest somewhat agreed with this statement. To a large extent, this depends on the specific task/scenario and on the medical simulator itself. A number of social interactions cannot be assessed by simulations.

Teamwork is essential in all clinical areas, incl. and in obstetrics and gynecology. It should be one of the tasks/scenarios to be applied for learning in the simulation training. Only half of the respondents indicated that students demonstrate good communication skills with other health professionals, four somewhat agreed and one disagreed with this statement. This conclusion suggests that additional simulation training of medical students for team work should be implemented.

Only four of the lecturers supported the statement that during the simulation task the students demonstrated critical thinking skills acquired during the training, ability to acquire necessary data and report the findings. Half of them somewhat agree with this statement and one disagrees. The assessment of the acquired knowledge and the subsequent work on the gaps and mistakes are one of the foundations of the quality education of the students. Two-thirds of the participants in the current study indicated that they were able to assess students' acquisition of knowledge and skills during the individual scenario, which may be due to the larger group size and is an indirect criterion for the need to conduct simulation training in smaller groups.

4. Qualitative analysis among experts in the field of application of simulation technologies in modern higher medical education

A qualitative study of the expert opinion of persons directly involved in the introduction, application and evaluation of the use of simulation technologies in the education of students of health specialties was conducted. The main objective of this study is to identify the place of ST in the educational process of students and to define the benefits and barriers to the application of simulation technologies in a medical university in Bulgaria from the point of view of the respondents' expertise. Ethical issues in the training of health professionals with simulators are a new aspect of medical education with the application of simulation technologies, and the present study aims to clarify this in the conditions of a Bulgarian higher medical school.

4.1. Determining the place and advantages of simulation technologies in modern higher medical education

The representatives of the manufacturers of simulation technologies define the use of simulators in the modern training of students and specialists in higher medical schools as very important and essential, pointing out the main advantages of the application of simulation technologies - easier perception of the theoretical material in the fundamental disciplines (anatomy, physiology and others.); creation of technologies and situations close to reality; use of guidance modes during training; repeated use of simulation technologies

with a reduction in the probability of errors; acquiring practical skills in a relaxed atmosphere, as well as more efficient ways for shorter deadlines:

"Simulation in medical education is a modern technology for teaching and assessing practical skills, abilities and knowledge based on realistic modeling, simulating a clinical situation or a single physiological system, for which biological, mechanical, electronic and virtual (computer) can be used models" (Expert 2.).

"Simulators, mannequins, simulators and mockups are high fidelity - extremely close to reality! Training with them allows to shorten the time between theoretical training and clinical practice as much as possible. The learner abstracts from the meeting with a live patient and learns skills in a relaxed atmosphere" (Expert 1.).

"Simulators enable the customization of endless variations of case studies and pathologies. The simulators are equipped with real surgical instruments that help facilitate the transition from a simulated to a real work environment' (Expert 2.).

The representatives of the administrative management and the staff in the provision and maintenance of simulation technologies demonstrate different awareness of their place and their advantages in modern higher medical education. As expected, managers and staff in simulation technology centers show excellent knowledge of the role and benefits of simulation technology as an "*integral part of training in modern medical universities. They are validated methods for more effective retention of knowledge both among students and among interns and practicing doctors who wish to improve themselves in a certain field"* (Expert 3.).

"Innovative educational technologies are becoming increasingly popular among lecturers in higher education institutions. Artificial intelligence appears to help natural intelligence" (Expert 4.).

Experts from this group clearly outline the leading advantages of simulation technologies: the better cognitive and practical skills acquired after a certain number of repetitions of the relevant simulator or simulator, where its type does not play such a big role in the final result; higher efficiency of the educational process in terms of required time, resources, while ensuring safety for the patient; the possibility of training on certain pathological conditions and diseases, even when patients with the relevant diagnosis are not available; objective evaluation of the achieved learning results.

"The ability to imitate diseases and conditions by means of software and hardware means allows not only closeness to the actual experience, but also the ability to objectively evaluate (quantitatively, qualitatively and

temporally) the assistance provided. This sets completely new standards for both training and assessment of future health professionals and opens up new horizons in the field of education" (Expert 5.).

Faculty with expertise in the application of ST demonstrate an in-depth description of its growing global importance, importance, and benefits of its application in the education of health majors students:

- creating desired situations that are as close as possible to actual ones (Experts 8., 10-14.).
- possibility of multiple repetitions until the desired result is achieved (Experts 6.-11.).
- more effective development of practical skills and routine in movements (Expert 6., 8-15.).
- recreating behavior protocols, especially in emergency situations in a safe, calm and controlled environment (Experts 9.-14.).
- exercising a sequence of actions and different scenarios for the development of states (Experts 7. and 9.-14.).
- avoiding the trainees' concern that the experiment is associated with pain and fear for the patient (Experts 6.-15.).
- possibility for easy planning of the learning process (Experts 13.-15.).
- lack of limitation from the presence of a suitable clinical case (Experts 13. and 14.).
- lack of ethical restrictions (Experts 9.-15.).

The specific opinions of the experts on the individual advantages of simulation technologies are as follows:

"Simulation technologies should be seen as an indispensable part of higher medical education. Advances in information technology and engineering have enabled the development of increasingly sophisticated simulators to meet the needs of medical education. The main advantage is the possibility of creating a medical scenario in front of the student/intern, which can be rehearsed until it is perfected, which is impossible in a real environment' (Expert 11.).

"The opportunity for trainees to put their theoretical knowledge into practice, train their clinical thinking and go from mechanical recitation of the memorized treatment to its actual application, make a differential diagnosis of the various conditions and see the response to their actions and how long they it takes to draw up and carry out their treatment plan' (Expert 10.).

"Healthcare professionals trained in simulators have been shown to have a much faster and more effective learning curve in a real-world environment afterwards" (Expert 9.).

4.2. Main barriers to the application of simulation technologies

The representatives of all three groups of experts indicate important barriers to the wide application of simulation technologies in the education of students and specialists in health specialties.

According to experts, manufacturers of simulation technologies, the leading obstacle to use of simulation training is the non-adapted curricula, in which the combination of traditional practical classes with patients and those of simulators is not included. A subsequent barrier, according to them, is the lack of a sufficient number of trained lecturers in various specialties who know all the possibilities of specific simulation technologies with a view to their more effective application.

"*Student training programs should be redesigned to include simulation training. Lecturers should be provided in the various specialties and they should be directly involved in teaching with the help of the simulators. This process takes time, and lecturers, in most cases, are excessively busy with their healing work, i.e. they do not have time to acquire in-depth knowledge about simulators, as well as about teaching with the help of simulation technique'* (Expert 1.).

The representatives of the administrative management and the staff in the provision and maintenance of the simulation technologies define several main barriers to the introduction of the simulation technologies, some of which are repeated with those of the other two groups of experts: The limitations of the normative regulation of the use of simulators (Expert 3.*). The insufficient number of trained* and willing lecturers to apply simulation technologies in the education of students, interns and health professionals external to the medical school (Experts 3.-5.). *The high cost of ST* and the limited financial resources of the higher medical school (all experts in this group). *The absence or insufficient area* for the deployment of a simulation center or equipment in the relevant main units (Experts 3. and 16.). All experts, incl. and the head of the financial department of the higher medical school, attach importance to financial resources, but two of the participants emphasize that they are not leading (Experts 3. and 5.):

"The financial capabilities of the relevant higher medical school are not decisive. There are many low-budget options for implementing simulations in training" (Expert 17.).

"The limited funding under European programs for the purchase of simulation equipment" (Expert 16.).

Insufficient or unmotivated human resources are indicated as a barrier to the application of simulation technologies mainly by managers and workers

in simulation technology centers, which is also confirmed by the following opinions:

"Another possible reason is the lack of sufficiently motivated lecturers to pave the way for such a new teaching modality (in any case, at the beginning, a lot of sacrifices are required at the expense of the free time of these people - to devote their time and energy to of this activity). In most cases, purchased simulators are "scattered" on the clinical units, where they remain unused, or are placed in rooms that are adapted and not built for this purpose" (Expert 3.) .

"The second barrier is the insufficient desire on the part of the lecturers to change their mentality and stereotype in the educational process" (Expert 4.)

"The obstacles are mainly in conservative teaching methods" (Expert 5.)

The lecturers define very clearly and expand the spectrum of possible barriers to the application of simulation technologies, with the exception of one who says that " *there are no barriers to their use, but the real contact with the patient and the individual approach to him is impossible to reproduce"* (Expert 6 .):

- Insufficient number of lecturers prepared to work with ST (all experts, except Expert 6.).
- Large number of students in the groups (Expert 9.).
- Overload of lecturers engaged in ST and many other tasks.
- Underestimation or reluctance on the part of educators to introduce or more widely apply
- Insufficient number of CTs of high class or suitable for the respective clinical specialty (Experts 8., 11. and 13.).
- Amortization of some simulation technologies, except those with virtual reality.
- Financial resource for building and furnishing a simulation center, as well as providing the necessary maintenance and consumables (all experts except Expert 6.).
- Effective logistics to ensure maintenance, supplies and occupancy of the halls and equipment of the simulation technology center (Expert 9.).
- Need for a specialized simulation center.

"For a session to be effective, the group of learners must be small. At least two trainers (one operator and one moderator) who know the capabilities of the simulators in detail are needed . Space is needed, and it would be best and most realistic to have premises that are specially selected and equipped for this purpose. In addition, lecturers are often engaged in both teaching and

healing and scientific activities, which burdens them and prevents them from concentrating sufficiently in each of these directions" (Expert 9.).

"Traditions that until now have not included this type of training, reluctance of older lecturers to change their teaching methods and train themselves to use new technologies" (Expert 10.) .

4.3. Provision of simulation technologies and their use in the relevant higher medical school

All lecturers and representatives of the administrative part of the simulation center and the medical school are of the opinion that the use of simulation technologies is widely advocated in the educational process of the two higher medical schools. The Medical Simulation Training Center of the Medical University - Plovdiv is the largest simulation center for medical specialists in Bulgaria and has both the necessary simulators and internationally recognized training methods in over 20 medical specialties. All simulators and simulators in this center are integrated into the learning process, and part of the courses are also offered in the line of postgraduate training for a fee.

In 2019 at the Medical University "Prof. Dr. Paraskev Stoyanov" - a Center for Simulation Techniques and Medical Equipment was opened in Varna, the base of which is supplemented and renewed annually according to the university's financial capabilities. Most experts believe that this center is "*one of the best technically equipped simulation centers in Bulgaria",* but nevertheless there is an opportunity for additional provision of equipment and personnel. To harmonize and integrate the pre-clinical and clinical training of students at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, this center uses available simulators in the field of surgery, ultrasound examinations, emergency medicine and anesthesiology, obstetrics and gynecology, as well as dental medicine. The experts shared that the purchased simulation technique is being used to its full potential to a large extent, except for one of the experts who said that "*its use is insufficient'* (Expert 9.).

One of the experts emphasized that simulation training does not only involve the use of simulation equipment, such as "*in psychiatry, simulation approaches can be engaged in the training of students"* (Expert 10.).

4.4. Application of simulation technologies in the training of students and specialists

Experts from manufacturing companies point out that students have virtual libraries supported by videos and images in simulation technologies.

Experts with teaching experience use simulation technologies extensively in training, some even on a daily basis and at full capacity. They declare a positive attitude on the part of the students, which is expressed in increasing the knowledge, skills and interest of the students.

"It is getting to a situation where one of the first questions foreign students ask is whether the university has (and whether it offers) simulation training" (Expert 3.).

The lecturers consider the important contribution of the training and preparation they received before starting work with simulation technologies, the greater security and peace of mind when conducting practical classes with smaller groups, the constant and consistent upgrading of acquired skills and knowledge.

Lecturers usually note initial discomfort among students, but after a certain and individual period of adjustment, abstraction, familiarization with working with simulation technologies, they focus on acquiring skills and knowledge, and the interest in using simulation technologies on the part of educators grows. They also highlight the provoking of logical thinking, self-criticism towards gaps in knowledge and the desire to fill in this knowledge, as well as to improve skills. Greater confidence is felt due to the fact that there is no danger of making a fatal mistake. Educators report that one of the advantages of using simulation learning is that it is easier to engage and retain the attention of learners.

The weaker involvement of simulation technologies in the training of specialists is noted, which is not fully regulated by law (Expert 9.). At the same time, experts declare certainty regarding the positive and great future of the application of simulation technologies in the education of students and specialists.

"Students are receptive and look forward to exercises using simulation technologies. I feel comfort and satisfaction that I can easily and comfortably convey my practical skills to students and visually demonstrate a rare condition in medicine" (Expert 7.).

"They are not used enough in graduate training. There are no regulated sessions and topics, but individual spontaneous, short simulations are held, and rarely" (Expert 9.).

"This type of training allows for practice and refinement of manipulations while removing tension and fear" (Expert 10.).

4.5. Educators' barriers to the widespread use of simulation technologies in the education of medical students and interns

All experts are of the opinion that lecturers play a key role both for the effective use of simulation technologies in the relevant unit and for building a positive attitude of students towards simulation training. The application of simulation technologies requires several important points, which, if not observed, are a serious obstacle on the part of educators:

- Developing one's own attitude for real and serious learning, not as a game;
- Putting enough time and effort into self-preparation and pre-playing the situational tasks and scenarios;
- Acquaintance with the possibilities and limitations of simulation technologies;
- Readiness to respond to technical problems;
- Development of an appropriate, flexible and adaptable methodology for teaching and assessing students and their knowledge;
- Allocating sufficient time to study as provided by the scenario.

Two of the lecturers share that the higher age of the trainers is an important barrier to the effective application of simulation training in higher medical schools.

"The most serious problem related to the application of simulation technologies in education is the limited time of medical educators, which they tend to devote to students/specialists. Without a qualified mentor to supervise and guide the training, simulators are nothing more than video games' (Expert 3.).

"There is a huge amount of technology implemented in modern simulation technologies, this probably prevents some educators from confidently and freely handling the relevant simulation technology. It is possible that some lecturers are worried about unintentionally damaging the technique" (Expert 5.).

"Underestimation of learning with simulation technologies due to ignorance of the advantages of this teaching method" (Expert 9.).

"The lack of prepared training programs, forcing the lecturer to 'improvise'" (Expert 13.).

4.6. Ethical problems of the application of simulation technologies in education in higher medical schools

All experts are of the opinion that ethical issues have no place in the application of simulation technologies in the education of students and specialists in health specialties. Three of them share the opinion that simulation

training even eliminates some of the ethical considerations in direct training on patients (Experts 3., 6. and 8.). One expert even believes that manipulations on patients should be preceded by mandatory successful coverage of training and practice on the simulators.

Experts in the field of medical ethics also support the opinion that there are no ethical problems in the application of simulation technologies in the training of students and specialists.

"The training, which includes simulation technologies, develops the knowledge, skills and attitudes of the health professionals in training, potentially protecting patients from unnecessary risk, thus meeting one of the main principles in modern bioethics - beneficence and non - harm . " Moreover, simulation-based training is also institutionalized in other high-tech and risky professions, such as aviation and nuclear power to maximize training safety and minimize risk. In the context of health professions and medical education, simulation technologies do not pose ethical problems, insofar as they can support the development of behavioral and practical skills, but do not replace the real contact between the health professional/doctor and patient" (Expert 3.).

"I have no such observations, on the contrary, through simulation technologies, emotional states that would arise in certain topics are eliminated and the details in the training can be specified as objectively as possible!" (Expert 6.).

"I believe that it is much more ethical, safe and effective that the training is carried out first on simulators and only when a certain level of competence and success on the simulator is reached, to move on to manipulations on real patients" (Expert 9.) .

4.7. Legal and financial problems of the application of simulation technologies in education in higher medical schools

Almost all experts (n=15; 88.24% of cases) share the opinion that there are no legal problems on the application of simulation technologies in education in higher medical schools. From the point of view of the legal expert, there are legal problems that should be solved in order to provide effective training, first of all, to the specialists, so that they can be included in the practical part of their training and the hours of working with the simulators: "When *acquiring specialty in certain professional fields in the health care system, a mandatory medical and diagnostic activity is carried out with a certain number of manipulations with patients, which must be performed in order to cover the legal criteria and standards for acquiring the relevant medical specialty from the regulated professions. Simulation training is*

envisaged as an optional elective and legislative changes are needed to include hours of work with simulators as part of the practical training of postgraduates, PhD students and undergraduates' (Expert 16.). According to another expert, the legal problems consist in the fact that *"there is no regulatory framework for the use of simulation technologies in medical education - neither in terms of horariums, nor in terms of Uniform State Requirements"* (Expert 3.).

Financial barriers are outlined by almost all experts as very significant, especially for smaller higher schools or faculties, although, in the words of one expert, finances should not be the driving force when "if there is a will and desire, it is possible to introduce simulation training, *starting with various task -trainers, some of which can be created from improvised means'.*

"Expenses for the high cost of high-tech equipment and consumables for simulation training should not be the driving force and a return on investment in financial terms must be pursued due to the positive results of such training from a humane perspective as a result of reducing errors in all health and medical specialists" (Experts 5. and 10.).

"In principle, high-tech equipment with simulation technologies has a high initial cost to acquire and subsequently to maintain. From a purely financial point of view, perhaps the use of this type of technique is not fully justified. But from a humane point of view, if the use of this type of technique minimizes medical errors subsequently, even to a small extent, and this leads to an improvement in public health care as a whole - then the financial side of the matter should not be the driving force at all in making a decision. " (Expert 5.).

"The high initial cost could be an obstacle, but with proper training and operation, it would most likely have a satisfactory long-term effect - financially, educationally and ethically" (Expert 10.).

Two of the experts (a lecturer and an accountant) add that the high financial costs of purchasing and maintaining the equipment should also include the system costs of paying lecturers for their training (national or international seminars), additional remuneration given the need to conduct the training with students in smaller groups than the traditional size, and so that faculty can be dedicated to their work with simulation technologies.

"Simulators and supplies are expensive; the number of students is large; in order to have more lecturers, there must be funds for salaries; in order for lecturers to have more time, it is necessary that the salary does not require working at more than one workplace" (Expert 9.).

4.8. Perspectives of simulation technologies in higher medical schools in Bulgaria

The recommendations proposed by all experts are rational and consistent, addressing all the issues raised in the previous discussions. Fundamental are the proposals made for the adoption of a regulatory framework for the mandatory use of simulation technologies in medical education in relation to the Uniform State Requirements for the planned horary, credits and disciplines in which training with the application of simulation technologies will be embedded.

"The active membership and collaboration between simulation medicine specialists in the Bulgarian Society of Simulation Medicine unite their efforts and assist the state authorities to take the necessary measures to adopt and popularize simulation training" (Expert 3.) .

An important element of the effective conduct of training with the application of simulation technologies is the construction or allocation of a separate building/sufficient area for this purpose. It is necessary to provide institutional support for the development of simulation training through the purchase and maintenance of equipment, the training of a number of qualified and interested personnel adequate to the workload. To cover the high costs, a proposal was made to provide the necessary funding from the Ministry of Education and Science.

The development of an adaptive methodology for teaching, evaluating and certifying the acquired knowledge is another proposal to take into account the restructuring of the organization of practical training. An important element is the conducting of preliminary training for lecturers to work with simulation technologies to master the technique for teaching and assessing students. In addition, one of the experts *also offers the possibility of conducting courses for persons external to the educational institution (doctors, policemen, firefighters, sailors, etc.)* (Expert 8.).

Additional financial incentives for lecturers working with simulation technologies in the education of students and specialists would contribute to the achievement of higher results and wider application of simulation technologies.

"In principle, the use of simulation technologies (ST) should be regulated as a requirement in the regulations concerning the training of future and current medical specialists. …. ST can and should be imposed as a learning standard and as a means of assessing acquired knowledge and skills' (Expert 5.).

"An intensive study of the offered products and a search for opportunities to integrate them into existing curricula is necessary. The diversity of STs and the competition in the market offer inexhaustible opportunities to improve training programs' (Expert 5.).

"More lecturer training is needed, including visiting large simulation centers and symposiums abroad. It is necessary to encourage lecturers engaged in this type of training" (Expert 8.).

"The problem is the large general workload, which does not allow me to gain sufficient confidence in operating the dummies and running the simulations. It takes time to pre-play – once as a trainer and once as a trainee. Therefore, at least one more lecturer and free time are needed. These two conditions are rarely met" (Expert 9.).

CONCLUSIONS

In this dissertation, the attitudes, impressions and acquired experience of several groups of students, lecturers and experts are analyzed with the help of the toolkit developed for the purpose.

The obtained results convincingly show the readiness of students and lecturers to actively participate in the application of simulation-based learning. They show satisfactory awareness of this issue and are aware of the undoubted advantages of simulation technologies – efficiency, individual work in a realistic environment, the opportunity to repeatedly repeat practical exercises and consolidate acquired knowledge and skills, safety for the patient, etc. Specifically:

1. Simulation training is characterized by satisfactory quality, sufficient efficiency, perspective and safety for the patient. Education with the application of simulation technologies is built on the basis of the theory of experimental learning and allows significant activation of learners. An understanding of the foundational theories of education underlying simulation learning assists educators in developing new simulation programs. The methods of this training are seen as an established component for both medical students and residents. They are cost-effective, so their use in recent years has been associated with significantly better outcomes, especially in behavior towards high-risk patients and in emergencies.

2. The different types of simulation technologies studied are presented systematically in the literature review, depending on the technology and its application. The review of articles and reports from conferences in Bulgaria shows the very few studies of the effectiveness of simulation training applied in higher medical schools.

3. Similar results were found among the surveyed students, lecturers and experts regarding most of the analyzed questions. Almost all participants confirm that simulation-based training supports the development of clinical skills and competences, as well as gaining confidence. Less than half of the participants in the experimental study were aware of different types of simulation technologies. The trainees demonstrate satisfactory awareness and realize the undoubted advantages of simulation technologies – efficiency, individual work in a realistic environment, the possibility of repeatedly repeating the practical exercises and consolidating the acquired knowledge and skills, safety for the patient, etc.

4. All medical and dental students have the opportunity to train on a simulator during a simulation-based exercise, but more than half believe that there is

a need to increase the number and increase access to simulators (57%). especially for dental students in BEO (63%).

5. According to 57.4% of medical students and 62.2% of dental students in BEO, the use of simulation technologies during practical classes is insufficiently represented, and the dependence between this indicator and the type of specialty is statistically significant ($p<0.0001$).
6. Students are satisfied with recreating different clinical situations when using the simulators during their training, and future doctors ($p<0.0001$) and BEO trainees (58.1%) ($p<0.0001$) share this to a higher degree than the alternative type of major and language of study.
7. ST training instructors are always present at the practical classes of the medical students in BEO, and least often at the dental medicine students in AEO ($p=0.04$). Students (about 1/3) and almost all lecturers believe that the number of instructors is not sufficient to implement effective simulation training.
8. The construction of a specialized simulation center would increase the effectiveness of simulation training with additional simulators and seminars in order to increase the accessibility of simulation training.
9. Conducting training with the application of simulation technologies to students of the specialty "Obstetrics and Gynecology" leads to higher success rates and better skills in the students of the experimental group, compared to the students of the control group.
10. The main barriers to the wide application of simulation technologies for training students and specialists in health specialties are as follows: the unadapted curricula, in which the combination of traditional practical classes with patients and those of simulators is assumed; the lack of a sufficient number of prepared and motivated lecturers in various specialties, reluctance on the part of lecturers to introduce or more widely apply simulation technologies in education, as well as the large number of students in the groups; the high costs of purchasing and maintaining ST compared to the limited financial resources of the educational institutions, the lack or insufficient area for placing a simulation center or equipment in the relevant main units.
11. The prospects for the development and positioning of simulation technologies in a worthy place and wide application in the education of students in higher medical schools are outlined by adopting a regulatory framework for the mandatory use of ST in the education of students of various medical specialties; institutional support by providing equipment and a sufficient number of trained and motivated personnel; development

of an adaptive methodology for teaching, assessment and certification of acquired knowledge.

The present study could stimulate scientists in Bulgaria to also organize and conduct complex research on this current and socially significant issue.

DISSERTATION CONTRIBUTIONS

1. A detailed and in-depth historical review of the development and application of simulation technologies for teaching students of various medical specialties has been implemented.
2. The present multifaceted study is the first initiative in our country regarding the effectiveness and perspective of the use of modern simulation technologies in the training of students of clinical medicine and dentistry.
3. For the first time, a survey was conducted on the attitudes and experience of the application of simulation technologies in the education of students from the specialties "Medicine" and "Dental Medicine".
4. An experimental study was conducted for the first time in Bulgaria to evaluate the effectiveness of the application of ST in the training of the discipline "Obstetrics and gynecology" of students from the specialty "Medicine".
5. The knowledge, subjective experience and experiences of students and lecturers in working with simulation technologies in the discipline "Obstetrics and Gynecology", specialty "Medicine" were analyzed.
6. The first qualitative expert analysis was carried out to identify the main barriers to the wide application of simulation technologies for training students and specialists in health specialties in Bulgaria.
7. The overall analysis of the collected data allows for recommendations to be made to the relevant institutions for the introduction of routine and effective training of students and interns in higher medical schools in Bulgaria.

LIST OF DISSERTATION-RELATED PUBLICATIONS

1. Chernogorova , G., **Grancharov , D.** , Bliznakov , Zh . Assessment of the effectiveness of medical simulators in the practical training of medical students: preliminary results in MU-Varna. *Scripta Scientifica Hello Publicae* , 2019;3:28-34.
2. **Gruncharov, D.** , Yotov, T. Increasing the medical training and qualification of seafarers through the use of simulation technologies. *Varna Medical Forum* , 2021;10(2):201-205.
3. Simeonov , H., **Grancharov , D.** , Georgiev , T. Arthroscopic simulator use: initial results. *Scripta Scientifica Hello Publicae* , 2021;7 Online First.