Original (RCT) Article

Comparing low fidelity simulation/model and hybrid simulation techniques for teaching how to perform intramuscular injections: a randomized control trial

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Abstract

Objective: To compare low-fidelity simulation/model and hybrid simulation techniques for teaching how to perform intramuscular injections.

Methods: The randomised controlled trial was conducted at the Department of Midwifery, Adnan Menderes University, Aydin, Turkey, from May 2 to 25, 2018, and comprised students enrolled in the course of Basic Principles and Practices in Midwifery II. The students were divided using simple randomisation into intervention group A and control group B. Those in group A were taught intramuscular injection at an assembly which was prepared through hybrid simulation method, while those in group B made use of the model routinely employed in the midwifery programme. Data was collected using a descriptive characteristics form, the General Self-Efficacy Scale, the State Trait Anxiety Inventory and the Guide to Performing Intramuscular Injections into the Ventrogluteal Site. Data was analysed using SPSS 20.

Results: Of the 73 students, 37(50.7%) were in group A and 36(49.3%) in group B. There was no difference in terms of age between the groups (p>0.05). Group A had better total General Self-Efficacy Scale scores compared to group
B (p<0.05). Mean score of group A in State-Trait Anxiety Inventory was lower than that of group B (p<0.05). The mean score of group A was also higher in the Guide to Performing Intramuscular Injections into the Ventrogluteal Site compared to group B (p<0.05).

**Conclusion:** Students using hybrid simulation method had better levels of self-efficacy and skill as well as lower levels of anxiety compared to those trained on the conventional method.

**Key Words:** Hybrid simulation, Low-fidelity simulation, Intramuscular injections, Midwifery students.

**Introduction**

The use of simulation in health education is a method of teaching processes under circumstances that imitate real-world conditions by providing students with a virtual or artificial experience in a safe, risk-free environment. Within the complex structure of a healthcare system, clinical practice sites are limited and midwifery students are further prevented from acquiring appropriate and adequate practice due to the currently shorter stays of patients at hospitals and the fact that students spend less time in clinical settings for reasons stemming from the educational system. It is for this reason that students need to be supported with different educational techniques so that they can graduate with appropriate and adequate clinical experience they need. When the characteristics of simulation-supported education are examined, it can be seen that this method is effective in meeting students’ needs for experience. Simulation-supported education allows a student to experience a virtually close-to-life experience more than once, to work in a safe environment where continuous and planned practices are implemented, to repeat the experience without harming or wearing down a patient, and to have the opportunity to make and learn from mistakes. Simulation techniques are classified as manikins and models which have low technological features (partial task trainers, low-
fidelity simulation/model), impersonation of the patient role by a healthy individual (standardised patients), computer-enhanced simulations (screen-based computer simulators), simulations used in learning complex functions (complex task trainers), and integrated simulations in which multiple ways of simulations are used (hybrid simulation).\textsuperscript{1,3} Studies have indicated that simulated applications used in the transition of students from laboratory and class settings to real-life situations encourage them to the extent that their level of competence improves, as evidenced in the improvements observed in their increased levels of competence and recollection of correct procedures.\textsuperscript{4-8}

However, the most important point is to determine the simulation method that contributes most to student education.

Self-efficacy refers to the belief of individuals in their ability to be effective in life circumstances, their confidence that they can initiate the necessary steps and get results. A strong perception of self-efficacy increases success and wellbeing. A student who has a high level of self-efficacy is able to participate in the learning process on cognitive, motivational and behavioural levels to work systematically and regularly, displaying a higher level of achievement.\textsuperscript{9} At the same time, the intense anxiety that accompanies the education process is known to be an important factor that adversely affects a student’s achievement.\textsuperscript{10,11} It is therefore important that educators take into account which educational techniques are instrumental in making students feel more competent and effective and less anxious. In recent years, it has been observed that most evidence-based simulation studies conducted with midwifery students have evaluated the effectiveness of using simulation.\textsuperscript{12-14} It must be said nevertheless that a comparison of different simulation techniques is as much needed as studies on the effectiveness of using simulation. Such comparisons will help educators develop new strategies and, in doing this, provide students with the opportunity of reaching levels of optimal success. Very few evidence-based studies were found to have been conducted with midwifery students that
compared different simulation techniques. In addition, the expanding roles of midwives, patient safety issues, and overwhelmed midwifery curricula require midwife educators to consider using the most effective teaching strategies. In particular, they must consider the advantages and disadvantages of each simulation technique in developing students' physical examination skills before engaging in clinical practice. The current study was planned to examine the efficacy of teaching intramuscular (IM) injection practice to midwifery students through low-fidelity simulation/model and hybrid simulation on their levels on self-efficacy, anxiety and skill that they experienced during the process of learning.

Subjects and Methods

The randomised controlled trial (RCT) was conducted at the Department of Midwifery, Adnan Menderes University, Aydin, Turkey, from May 2 to 25, 2018, and comprised students enrolled in the course titled, ‘Basic Principles and Practices in Midwifery II’. After getting approval from the institutional ethics committee, the sample size was calculated in line with literature. With effect size $d=0.6625722$ and at $\alpha=0.05$, with a confidence interval (CI) of 95% and a power of 80%, power calculation was done using G* power.17 Those included were students aged 18-30 years, while graduates of the Health Vocational Schools were excluded because they already had experience of dispensing IM injections. The subjects were separated into intervention group A and control group B by simple randomisation. Students included in the randomisation were assigned numbers in the order of their student numbers, with the first student being given the number 1, and the other students numbered in consecutive order. The students were placed in groups in accordance with the randomisation table provided on the website www.randomizer.org (Figure 1). Data was collected using a descriptive characteristics form (DCF), the General Self-Efficacy Scale (GSES), the State Trait Anxiety Inventory (STAI) and the
Guide to Performing Intramuscular Injections into the Ventrogluteal Site (GPIIVS). DCF consisted of a total of four questions on age, family income status, family type and status of willingness to enrol in the department. GSES is the most widely used general self-efficacy tool to measure a general set of expectations that an individual carries into new situations. A high score shows good self-efficacy. Psychometric properties of the Turkish version of the scale were evaluated in 1999. STAI determines event-specific and continuous anxiety levels separately. It has been adapted to Turkish. The State Anxiety Scale of STAI (S-STAI) evaluates the current state of anxiety, and the Trait Anxiety Scale of STAI (T-STAI) evaluates relatively stable aspect to find individual differences in “anxiety proneness.” Scores on the STAI have a direct interpretation: high scores on both subscales indicate higher anxiety level, while low scores represent lower anxiety. GPIIVS is part of the “Basic Midwifery Practice Guidelines and Assessments” and shows the steps to be taken in perfecting the skill of performing an IM injection. The form is composed of 35 steps. The possible minimum score on the guide is 35 points; the maximum is 105.

Data was collected in the laboratory class of the Basic Principles and Practices of Midwifery II course. This course is required in the midwifery first-year spring term and covers the teaching of basic midwifery skills. The course offers 4 hours of theoretical, 4 hours of laboratory and 8 hours of practical work. The subjects in the content of the course are first taught from a theoretical perspective and then laboratory education is offered with models, after which the students practise in the clinic on real patients under the supervision of a faculty member. The study was conducted in five stages. In the first stage, written informed consent was obtained, randomisation was done and the students were asked to fill out DCF, GSES and STAI by way of self-reporting.
In the second stage, the supervising researcher explained to the two groups of students together the purpose of performing IM injections, what they needed to learn and briefly gave them the theoretical background for the application. Then the researcher demonstrated three times the application on the model using the GPIIVS. After the demonstration, the intervention and control groups were taken into different laboratories and were asked not to leave until the practice was over. Thus, both groups saw only their own applications and were kept blinded to what the other group was doing. The purpose of this blinding was to prevent the students from forming a conditioned positive or negative opinion about the teaching.

In the third stage, the students in the intervention group performed IM injections in 3 minutes in accordance with the hybrid simulation prepared by the researcher in line with GPIIVS.\textsuperscript{23}

For this, the researcher developed scenarios in line with literature\textsuperscript{24,25} to distribute to each of the students attending the education. The scenarios presented case summaries that revealed the age, gender, education, civil status and other sociodemographic characteristics of the patients as well as information about their medical history and hospitalisations. They were designed to allow a real patient to play the role of an actual patient who would show the same reactions that a standard patient in real life would demonstrate while receiving an IM injection. The content validity and technical features of the scenarios used in the study were evaluated by three faculty members. Additionally, an ovine gluteus maximus muscle was fitted with a skin-toned nylon stocking to simulate and this was wrapped around the standard patient’s hip using stretch film. This facilitated the creation of a simulator that was as close to actual appearance as possible. Written consent was obtained from the standard patient participating in the study. The ovine gluteus maximus muscle used in the study was obtained from Adnan Menderes University’s Faculty of Veterinary Medicine(Figure 2).
Students in the control group made use of the model routinely employed in the midwifery programme to perform the injections into the ventrogluteal site, which they performed in 3 minutes and in keeping with the steps suggested in GPIIVS.23

In the fourth stage, students in the intervention and control groups were asked to again fill out the self-reporting GSES and STAI forms. In the fifth stage; the students in the intervention group were again asked to perform intramuscular injections into the ventrogluteal site in 3 minutes using the hybrid simulation technique and in keeping with the steps suggested in GPIIVS. During this practice, the researcher used GPIIVS to evaluate the students’ skills.

In the fifth stage, students in the control group were again asked to perform IM injections into the ventrogluteal site of the model in 3 minutes, in keeping with the GPIIVS steps.23 The researcher used GPIIVS to evaluate the students’ skills in performing the injections (Figure 3).

Once the study was over, the students in the intervention group were directed to complete their education on the traditional model, and the students in the control group were directed to complete their hybrid simulation education. Data was analysed using SPSS 20. Numeric data was expressed as mean ± standard deviation (SD), and categorical data as frequencies and percentages. The comparisons of two groups’ sociodemographic characteristics were carried out with chi-square test. Comparisons between the groups in terms of their GSES, STAI mean scores at the first and third stage (normal distribution) were carried out within dependent samples t-test. Data that did not distribute normally was analysed with Mann-Whitney U test. Comparisons between the two groups regarding their GPIIVS mean scores at the first and fifth stage (normal distribution) were carried out with dependent samples t-test. Data that did not distribute normally was analysed with Mann-Whitney U test. The limit of significance was p<0.05 for all tests.
Results
Of the 81 students approached, 73(90%) participated. Of them, 37(50.7%) were in group A and 36(49.3%) in group B. There was no difference in terms of age, income level, family type and school enrollment between the groups (p>0.05) (Table 1).
Baseline GSES mean scores showed no significant differences, but post-intervention, the difference was significantly higher for group A (Table 2).
Baseline STAI mean scores showed no significant difference between the groups, but post-intervention the scores were significantly lower for group A (Table 3).
Mean GPIIVS scores of group A was higher than group B (p=0.000) (Table 4).
Discussion
The sociodemographic characteristics, GSES and STAI mean scores of the intervention and control groups before the intervention were similar, indicating that the two groups were homogeneous prior to the intervention and that the groups were comparable in terms of their self-efficacy, competence and anxiety levels.
Following the intervention, students in the intervention group exhibited higher mean scores on the GSES subscale and on the total scale compared to the students in the control group and that this difference was statistically significant. Cohen et al.\textsuperscript{12} found that midwives and nurses attending a simulation-based education programme displayed a pronounced improvement in self-efficacy. These results are similar to the findings of the current study.
Following the intervention, students in the intervention group exhibited significantly lower mean scores on the STAI compared to the students in the control group in the study. The intense anxiety experienced over the course of
education is a factor that adversely affects a student’s achievement,\textsuperscript{10,11} and it appears that the hybrid simulation method, which more closely simulated real situations compared to routine models, was a more effective technique to address anxiety.

The intervention group exhibited significantly higher GPIIVS mean scores compared to the control group after the intervention in the current study. Scholes et al.\textsuperscript{4} evaluated the responses of student midwives in a simulation of postpartum haemorrhaging as part of an obstetrical emergency lesson and reported that a large majority of the students were quite successful in dealing with the situation before the emergency team arrived at the incident. Similarly, Catling et al.\textsuperscript{5} found that midwifery first-year students working in a simulation workshop prior to their clinical practice exhibited increased comprehension, self-confidence and improvement in their clinical skills, leading to an enhanced readiness to work in the clinical setting. In another study conducted with midwifery and nursing students, researchers demonstrated that education in a virtual class was effective in developing students’ skills regarding maternal and neonatal health practices.\textsuperscript{6} A study\textsuperscript{7}, meanwhile, showed that a neonatal resuscitation model structured specifically for midwifery students increased their success in the practical setting. Another study\textsuperscript{8} reported that a simulated clinical model devised to determine the amount of post-delivery blood loss was highly effective. One study\textsuperscript{15} found that progressive and medium-fidelity simulation yields better outcomes than low-fidelity simulation. These outcomes are shown that more advanced and moderate simulation produced better results than simulation at lower levels. These results are parallel to the findings of the current study.

The study has some limitations. Being a single-centre study, the findings are not generalisable. Besides, the entire dataset was based on self-reporting and the possibility of bias cannot be ruled out.
We recommend that future studies shall address these limitations and also compare the outcome of differently planned simulation techniques that are introduced into health education.

Conclusion

Students in the intervention group were found to be better in terms of their self-efficacy, competence and skill levels compared to students in the control group, and, similarly, their anxiety levels were lower.

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Conflict of Interest: None.

Source of Funding: None.

References


14. Andrighetti TP, Knestrick JM, Marowitz A, Martin C, Engstrom JL. Shoulder dystocia and postpartum hemorrhage simulations: Student
confidence in managing these complications. J Midwifery Womens Health 2012: (57), 55-60.


Table 1: Descriptive characteristics of the students

<table>
<thead>
<tr>
<th>Descriptive characteristics</th>
<th>Intervention group (n=37)</th>
<th>Control group (n=36)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, Mean ± SD</td>
<td>18.84±0.767</td>
<td>18.63±0.707</td>
<td>0.240*</td>
</tr>
<tr>
<td>Income status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income less than expense</td>
<td>5(13.5)</td>
<td>7(19.5)</td>
<td>0.558</td>
</tr>
<tr>
<td>Income equal to expense</td>
<td>32(86.5)</td>
<td>29(80.5)</td>
<td></td>
</tr>
<tr>
<td>Family types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>29(78.4)</td>
<td>30(83.3)</td>
<td>0.450</td>
</tr>
<tr>
<td>Large</td>
<td>8(21.6)</td>
<td>6(16.7)</td>
<td></td>
</tr>
<tr>
<td>Status of willingness to enroll in the department</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28(75.7)</td>
<td>23(63.3)</td>
<td>0.137</td>
</tr>
<tr>
<td>No</td>
<td>9(24.3)</td>
<td>13(36.1)</td>
<td></td>
</tr>
</tbody>
</table>

t-test, ** X^2 analyse were applied
SD: Standard deviation

Table 2: Students and General Self-Efficacy Scale (GSES) total and subscale mean scores

<table>
<thead>
<tr>
<th>GSES</th>
<th>Intervention group X ± SD</th>
<th>Control group X ± SD</th>
<th>t or Z/P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starting the behaviour</td>
<td>30.21±5.03</td>
<td>31.37±4.96</td>
<td>-0.618/0.426*</td>
</tr>
<tr>
<td>Maintaining the behaviour</td>
<td>25.32±4.32</td>
<td>24.56±4.78</td>
<td>1.226/0.815*</td>
</tr>
<tr>
<td>Completing the behaviour</td>
<td>18.03±3.16</td>
<td>18.11±3.41</td>
<td>0.683/0.643*</td>
</tr>
<tr>
<td>Struggling with obstacles</td>
<td>9.14±2.47</td>
<td>9.21±2.39</td>
<td>-1.694/0.433*</td>
</tr>
<tr>
<td>Total GSES</td>
<td>82.65±11.24</td>
<td>83.18±11.56</td>
<td>-0.321/0.715*</td>
</tr>
<tr>
<td><strong>Post-intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starting the behaviour</td>
<td>32.93±5.49</td>
<td>30.81±6.43</td>
<td>2.959/0.003**</td>
</tr>
<tr>
<td>Maintaining the behaviour</td>
<td>27.87±5.32</td>
<td>26.01±3.49</td>
<td>-3.153/0.002**</td>
</tr>
<tr>
<td>Completing the behaviour</td>
<td>19.78±2.96</td>
<td>18.88±3.56</td>
<td>-3.246/0.004**</td>
</tr>
</tbody>
</table>
Struggling with obstacles 10.62±2.11 9.61±2.03 2.569/0.046**
Total GSES 91.10±14.98 85.23±12.05 -7.073/0.000**
* t test was applied because normal distribution was observed. Values are P values.
** The Mann-Whitney U test was applied because normal distribution was not observed.
Values are Z values.
SD: Standard deviation

Table 3: Students and State Trait Anxiety Inventory (STAI) mean scores

<table>
<thead>
<tr>
<th>STAI</th>
<th>Intervention group X ± SD</th>
<th>Control group X ± SD</th>
<th>t or Z/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-intervention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-STAI</td>
<td>37.31±8.89</td>
<td>38.05±8.45</td>
<td>0.856/0.751*</td>
</tr>
<tr>
<td>T-STAI</td>
<td>41.96±6.63</td>
<td>40.84±5.09</td>
<td>-0.125/0.987*</td>
</tr>
<tr>
<td>Post-intervention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-STAI</td>
<td>32.02±8.81</td>
<td>35.12±7.82</td>
<td>2.037/0.045*</td>
</tr>
<tr>
<td>T-STAI</td>
<td>35.01±6.96</td>
<td>38.21±8.01</td>
<td>-4.746/0.068**</td>
</tr>
</tbody>
</table>
* t test was applied because normal distribution was observed. Values are P values.
** The Mann-Whitney U test was applied because normal distribution was not observed.
Values are Z values.
SD: Standard deviation.

Table 4: Students and Guide to Performing Intramuscular Injections into the Ventrogluteal Site (GPIIVS) mean score

<table>
<thead>
<tr>
<th>GPIIVS</th>
<th>Intervention group X ± SD</th>
<th>Control group X ± SD</th>
<th>Z/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-intervention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.02±5.36</td>
<td>21.86±2.85</td>
<td>-7.056/0.000*</td>
<td></td>
</tr>
</tbody>
</table>
* The Mann-Whitney U test was applied because normal distribution was not observed.
Values are Z values.
SD: Standard deviation.
Number of student: 81 meeting the criteria for the study

Excluded (n=8)

Graduates of the Health Vocational Schools = 8

Randomized

Number of students = 73

Intervention group = 37

Control group= 36

Figure 1: Randomisation flowchart.

Figure 2: Hybrid simulation setup used in the study.

First stage:
Informed Consent Form, DCF, GSES, STAI

Second stage:
The supervising researcher demonstrating three times the steps of the GPIIVS on the model for performing intramuscular injections into the ventrogluteal site
**Figure 3: Study implementation steps.**

**Third stage:** Intramuscular injections into the ventrogluteal site accordance with the model in keeping with GPIIVS.

**Third stage:** Intramuscular injections into the ventrogluteal site accordance with the hybrid simulation in keeping with GPIIVS.

**Fourth stage:**
GSES, STAI

**Fifth stage:**
* Intramuscular injections into the ventrogluteal site accordance with the model in keeping with GPIIVS.

* The researcher assessing students’ skills by using GPIIVS