Research article

The development and study of the effectiveness of a novel uterine contraction learning aid: A two-phase research study

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ABSTRACT

Background: Nursing students lack clinical experience in assessing intrapartum uterine activity, rating their ability and level of understanding as low or fair despite receiving theoretical instruction prior to attending clinical placements. Teaching model/aids may facilitate learning, however, purchasing additional models could prove expensive within many organisations. Limited exposure to skills rehearsal in school may contribute to student anxiety, stress, and perceived low self-efficacy when in clinical practice.
Objectives: To develop and assess the effectiveness of a novel Uterine Contraction Learning Aid as a training tool to expand the knowledge, attitude, and practice of nursing students.
Methods: A two-phase study conducted at The Institute of Nursing in Thailand. Phase I was underpinned by research and development. After first being considered for its quality, by five experts comprising an obstetrician, two midwives and two nursing instructors, the novel Uterine Contraction Learning Aid was assessed by 30 fourth-year nursing students with experience in assessing uterine contractions for its educational suitability. Phase II - Sixty year-three nursing students were assigned via matched-pairs to either an experimental or control group to evaluate the effectiveness of the Uterine Contraction Learning Aid, completing three questionnaires underpinned by the knowledge, attitude, and practice concept.
Results: Phase I- Descriptive statistics applied to survey responses indicate participants rated the quality of the Uterine Contraction Learning Aid highly in every aspect of learning skills, and perceptions of confidence. The overall production was rated at a good level. Phase II - An independent sample *t*-test was used to compare knowledge, attitude, and practice values in assessing uterine contractions between control and experimental groups. Participants in the experiment group had significantly higher scores in knowledge and practice when assessing uterine contractions compared to the control group ($t = 4.768$, $p < 0.000$ vs. $t = 3.630$, $p < 0.001$, respectively). There was no statistically significant difference in attitudes in relation to assessing uterine contractions between the two groups ($t = 0.188$, $p = 0.852$).
Conclusions: The novel Uterine Contraction Learning Aid can be used effectively to prepare nursing students prior to practicing with women undergoing intrapartum care.

1. Introduction

According to a recent survey, nursing students lack experience in assessing uterine activity, rating their ability to assess uterine contractions at a low or fair level of understanding (Park and Seo, 2022). Nursing instructors routinely provide theoretical instruction to nursing students about the concepts of uterine activity and contractions prior to assigning them to clinical placements with direct intrapartum patient care. However, because of the limitation of access to available teaching models used in the learning and teaching process, nursing students may face anxiety, stress (Liu et al., 2022; Ching et al., 2020), and perceived low self-efficacy when they then provide their services in delivery rooms (Kim, 2017). Perceived lack of confidence and competence could lead to an unsafe situation for the mothers, such as risk for uterine rupture due to having hypertonic uterine contraction. Additionally, buying additional models to use as media in the learning and teaching process could be excessively expensive within many organisations (Yimyam, 2016). Over many decades, there has been no new research conducted on innovations in assessing uterine contractions, with only five recent innovations relating to midwifery teaching and learning currently

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available: 1) an artificial perineum model (Poolpeum et al., 2011); 2) a breast model (Yimyam and Karnasuta, 2013); 3) a model for fetal position assessment (Nunchai and Saengnual, 2018); 4) a vaginal exam simulation box (Yimyam et al., 2018); and 5) a delivery mechanism wheel (Suwannarat et al., 2019). Three recent studies describing simulation-based skills training in midwifery show a positive result from utilizing the simulation to enhance nursing students' skill (Kumar et al., 2019; Çalım et al., 2020; Cha and Jeong, 2022).

2. Background

The Srisavarindhira Thai Red Cross Institute of Nursing provides a four-year nursing curriculum that produces graduate nurses in accordance with current health and social policy which focuses learners on expanding their knowledge through self-directed learning, creativity, and efficiency in utilizing technology to better meet the demands of contemporary health care. A successful outcome results in a bachelor's degree award. Graduates who then also complete a further eight subject requirements (maternal newborn nursing, midwifery, adult nursing, aging nursing, pediatric nursing, ethics and law, primary medical care, and psychiatric nursing) for the professional license exam will obtain a first-class honors degree in both nursing and midwifery professions and can practice both nursing and midwifery. Failure to pass the license exam will result in a nursing qualification only.

Nursing cadets in Thailand, also undertake at least 360 h of maternal newborn nursing and midwifery education to obtain a bachelor's degree for first-class honors in the nursing and midwifery profession (Thailand Nursing and Midwifery Council, 2019). The current curriculum (2022–2026) of the Institute includes 215 h of 'practicum in maternal newborn nursing and midwifery' and 90 h for the theory component (Srisavarindhira Thai Red Cross Institute of Nursing, 2022). The practicum offered by the Institute facilitates nursing cadets with skills rehearsal in a 'safe space', testing out their knowledge and understanding with the intention of addressing the practice-theory gap. This pedagogy has been used to evaluate students' skills of assessing a woman's progress in labour, to reduce potential risks and provide safe intrapartum care (Srisavarindhira Thai Red Cross Institute of Nursing, 2022). Clinical decision-making during labour and birth is dependent upon an accurate clinical assessment, such as, assessing uterine contractions for frequency and duration, and is an essential skill covered within the practicum. It is important for graduate nurses to have the ability to assess uterine contractions precisely, which is a second core competency regulated by a professional declaration mandated by government for first-class honors in the nursing and midwifery profession (Thailand Nursing and Midwifery Council, 2019; Chaiwuth et al., 2011; Bogren et al., 2022; Maniago et al., 2021).

The Srisavarindhira Thai Red Cross Institute currently owns two SimMoms (advanced full-body birthing simulators) and four pregnancy models, with approximately 200 nursing students registering for the Institute's practicum in maternal newborn nursing and midwifery each year. This resource deficit and the stringent preparation required of nursing students prior to practice (Nakayoshi et al., 2021), led the researchers to innovatively attempt to solve this problem in consultation with an engineer by designing and developing a novel Uterine Contraction Learning Aid. It was envisaged that the Uterine Contraction Learning Aid could be used with existing pregnancy models to increase the efficiency of existing models in developing better training in uterine contraction assessment. The researchers were interested in developing a computer program device that could connect to existing pregnancy models to regulate uterine contraction frequency and duration during assessment training. Researchers proposed to use the Uterine Contraction Learning Aid as an instructional medium to increase the readiness of nursing students, prior to practicing the assessment in real time clinical birthing rooms.

The Uterine Contraction Learning Aid comprised six air compressors with a mains board, for educational instructor/researchers to operate changes to the intra-abdominal pressure in the pregnancy model's sack to mimic the pattern of uterine contractions (Fig. 2). The prototype was designed to connect to an existing pregnancy model and was able to demonstrate three different patterns of uterine contraction namely the latent, active, and transition phases during labour as shown in Fig. 3. The Uterine Contraction Learning Aid is located within a box that requires an instrument that uses a computer program to increase the pressure of the pregnancy model's 'sack' until the internal pressure achieves an appropriate duration, interval, and intensity mimicking real human uterine contractions. For the study, the duration, interval, and intensity of latent contractions were set at 30 s duration, 5-minute intervals, and were mild–moderate in intensity. The active phase, contractions were set at 40 s duration, 3-minute intervals, and were moderate–strong intensity. In the transition phase, contractions were set at 50 s duration, 2-minute intervals, and were strong intensity. The program took approximately 15 s to adjust the patterns of uterine contraction.

3. Methods

3.1. Aims and objectives

This study was designed in two phases with the aim to address the practice-theory gap in uterine activity assessment, via simulated practice.

The objectives of this research were twofold:

1. Phase 1 – to develop and assess the quality of the novel Uterine Contraction Learning Aid.
2. Phase 2 – to determine the effectiveness of the Uterine Contraction Learning Aid in training to increase nursing cadets' knowledge, attitudes in relation to assessing uterine contractions, and practices via experimental and control groups.

4. Study design

4.1. Research framework

Phase I was linked to the concepts of research and development. There were four steps in developing the Uterine Contraction Learning Aid: 1) elucidating Uterine Contraction Learning Aid training requirements; 2) a quick design; 3) building the Uterine Contraction Learning Aid prototype; and 4) an evaluation of results (Yimyam et al., 2018). Three main aspects in evaluating the Uterine Contraction Learning Aid included production, learning skills, and perceptions of confidence. Phase II was linked to the concepts of knowledge, attitude, and practice. The interventions included a combination of providing knowledge obtained from assessing uterine contractions, conveying feedback, offering opportunities to practice assessing uterine contractions using the Uterine Contraction Learning Aid, and following up on nursing cadets' practices. The combination of interventions aimed to help increase knowledge and positive attitudes toward assessing uterine contractions, as well as the ability to practice assessing contractions (Bandura, 2012, 1997). The research framework is presented in Fig. 1.

4.2. Research methodology

Phase I aimed to develop and assess the quality of the Uterine Contraction Learning Aid. Phase II was a two-group, pre–post-test design that focused on the effectiveness of the Uterine Contraction Learning Aid in increasing nursing students' knowledge, attitude, and practice who were experienced in assessing uterine contractions. Following similar criteria to a recent study that assessed fetal positions, G*Power version 3.1.9.7 was used to calculate the sample. The power of the test was set at 0.80, statistical significance was at the 0.05 level, and the effect size was at the 0.50 level (Nunchai and Saengnual, 2018). Based on the
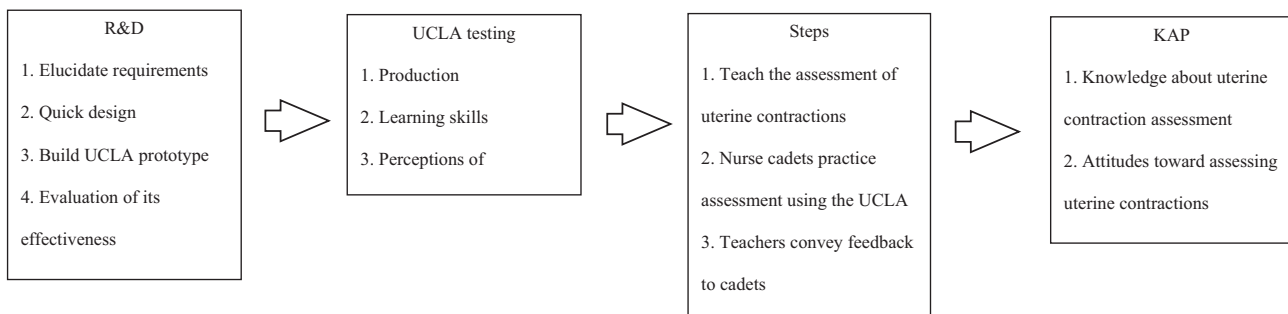
Fig. 1. Research framework.
Abbreviation. UCLA, Uterine Contraction Learning Aid; KAP, Knowledge Attitude and Practice; R&D, Research and Development.
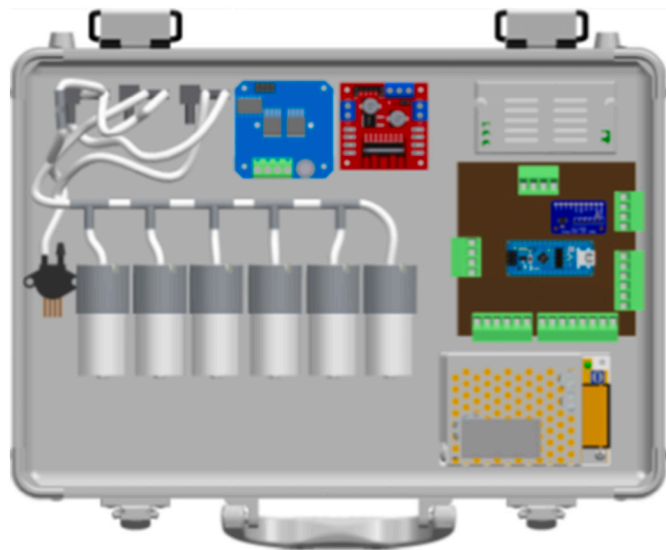
Fig. 2. Internal layout of the UCLA.
Abbreviation. UCLA, uterine contraction learning aid.

calculation, a minimum of 27 participants were required. Thirty participants were recruited first phase of the study.

Third-year nursing students who had no experience in assessing uterine contractions were the recruited population for Phase II. The same G*power software and criteria used in Phase I were also used in Phase II indicating a minimum sample size of 52 participants. To minimize the impact of incomplete data and/or insufficient sample size, the number of participants was increased by approximately 15 %. Matched-pair figures were based on nursing cadets' grade point averages and were used to assign the participants into either the experimental or control group. There were 60 participants in total, with 30 participants in each group. Of these, 15 participants' grade point averages were above 3.00 in both groups, and 15 participants' grade point averages were lower than 3.00 in both groups. An independent sample *t*-test was used to analyse the data.

5. Ethical considerations

This study was approved by the Institutional Review Board of the Institute of Nursing in Bangkok, Thailand (Phase I, Approval no. 07/2020; and Phase II, Approval no. 11/2020). The participants were informed about the purpose of the study and their freedom to decline participation in the study at any time. All participants provided a signed, written consent form prior to participating in the study.

6. Study instruments

6.1. Phase I

The Uterine Contraction Learning Aid was first considered for its quality by a group of five experts comprising an obstetrician, two midwives and two nursing instructors, prior to being assessed by 30 fourth-year nursing students before being used by Phase II participants.

The evaluation form describing the quality of the Uterine Contraction Learning Aid was developed by the researchers based on a literature review of developing innovative models and collecting data on their effectiveness (Yimyam, 2016; Yimyam and Karnasuta, 2013; Nunchai and Saengnual, 2018; Yimyam et al., 2018). Three main aspects were covered by the survey: production, learning skills, and perceptions of confidence. There were 15 items on the survey that were developed according to the Likert scale. The range of scores available on the quality of the Uterine Contraction Learning Aid survey form was set between 1 and 5 for each item, so that the total range of scores was between 15 and 75. Scores $\geq$80 %, or mean scores >4, were rated as indicating good quality. Scores of 60 %–79 %, or mean scores of 3.0–3.9, were rated as indicating fair quality. Scores <60 %, or mean scores <3, were rated as indicating poor quality. The five experts tested content validity. The index of item–objective congruence was 1.00. A total of 30 nursing students evaluated the reliability of the survey form. Cronbach's alpha was 0.84.

6.2. Phase II

In Phase II, the evaluation of the Uterine Contraction Learning Aid's effectiveness comprised three questionnaires. An assessment of knowledge regarding uterine contractions was covered by 20 items. The range of scores for each item was between 0 and 1. A high score indicated that nurse participants had a good understanding of assessing uterine contractions. An assessment of the students' attitudes in relation to assessing uterine contractions was covered by 10 items; the Likert scale was used to assess attitudes, and the range of scores was 10–50. An assessment of practicing skill in assessing uterine contractions was covered by four items. A 3-point rating scale was used to assess performance. Practice with an error under 5 s was rated as a score of 2, while an error between 5 and 10 s was rated as the score of 1, and an error of over 10 s was rated as 0. Three experts tested the survey's content validity: an obstetrician, a midwife, and a nursing instructor. The item–objective congruence was 1.00. The Kuder–Richardson 20 (KR-20) was used to analyse knowledge reliability, while Cronbach's alpha was used to analyse the attitude and practice questions. The reliability test results of knowledge, attitude, and practice yielded values of 0.80, 0.75, and 0.75, respectively.

7. Data collection

Information about the research project was shared with fourth-year

Fig. 3. The connection between the pregnancy model and the UCLA.
Abbreviation. UCLA, uterine contraction learning aid.

nursing students (Phase I) on-line whereas third-year nursing students (Phase II) received information during their orientation day via colleague nursing instructors (not from the researchers). The students who agreed to participate were asked to sign a consent form. The form is available to foster the transparent of the study. Phase II, data were collected from the control group prior to the experimental group to avoid data contamination. The participants in the experimental group were assigned a timeslot to use the Uterine Contraction Learning Aid with the researcher present and when they practiced at the delivery rooms of the University Hospital in Bangkok. Their knowledge, attitude, and practice values in uterine contraction assessment then were measured. The procedures of Phase I took approximately 30 min and 1 h for Phase II. All 30 participants of Phase I and 60 participants of Phase II who signed the consent form, complete their participation. They received a thank you card for their involvement.

8. Results

8.1. Data analysis

Statistical package SPSS Version 28 (License code 5f5119869c4164e0bda0) was used to analyse the data. In Phase I, descriptive statistics, such as mean scores (M) and standard deviations (SDs), were used to evaluate the quality of the Uterine Contraction Learning Aid. In Phase II, an independent sample t-test was used to compare knowledge, attitude, and practice values in assessing uterine contraction between control and experimental groups.

8.2. Overall results

Overall, the quality of the Uterine Contraction Learning Aid in its production, and in its role in teaching learning skills and building student confidence, was good. Considering each survey item, the

participants rated the quality of the Uterine Contraction Learning Aid highly in every respect, apart from production. They also rated the ease of moving the Uterine Contraction Learning Aid as being fair (Table 1).

8.3. Phase II: uterine contraction learning aid effectiveness in improving knowledge, attitude, and practice in nursing students

Participants in the experiment group had significantly higher scores in knowledge, attitude, and practice when assessing uterine contractions compared to the control group ($t = 4.768$, $p < 0.0001$ vs. $t = 3.630$, $p < 0.001$, respectively), whereas there was no statistically significant difference in attitudes in relation to assessing uterine contractions between the two groups ($t = 0.188$, $p = 0.852$), as shown in Table 2.

9. Discussion

9.1. Uterine contraction learning aid development and quality evaluation

The quality of the Uterine Contraction Learning Aid in terms of its production, and in terms of its ability to instill learning skills and confidence, was good overall (M = 4.36, 4.59, and 4.77, respectively). This finding was consistent with a study of the development of a pelvic examination box, which was found to be at a fair to good level in terms of its quality in assessing the progress of labour (Yimyam et al., 2018). In addition, the quality of the novel model for fetal position assessment training was excellent (Nunchai and Saengnual, 2018). It is important to note that the process of innovation requires a team of experts from various, relevant scientific fields. For instance, this research required an engineer, who calculated the uterine pressure that could bring about a real feeling of contraction in the latent, active, and transitional phases of labour. Specialists in computing, who were able to determine the duration, interval, and intensity of uterine contractions were also required. It is because of this collaboration, the Uterine Contraction

Table 1
The mean score of UCLA quality classified by single-item and overall quality.

Quality indicator	Min–Max	Median	M ± SD	Quality level
Overall production	2–5	4.5	4.36 ± 0.37	Good
Production per item	3–5	4	4.17 ± 0.79	Good
1. Having the correct size				
2. Easy to move	2–5	3	3.53 ± 0.82	Fair
3. Simple to use	4–5	5	4.77 ± 0.43	Good
4. The material is commonly found in the country	3–5	4	4.40 ± 0.62	Good
5. The product can increase understanding	4–5	5	4.80 ± 0.41	Good
6. The product is interesting	3–5	5	4.47 ± 0.68	Good
7. The product is long lasting	3–5	5	4.53 ± 0.68	Good
8. Having virtual reality to assess the duration, interval, and intensity of uterine contractions in the latent phase	3–5	4	4.03 ± 0.67	Good
9. Having virtual reality to assess the duration, interval, and intensity of uterine contractions in the active phase	3–5	4	4.40 ± 0.56	Good
10. Having virtual reality to assess the duration, interval, and intensity of uterine contractions in the transitional phase	3–5	5	4.50 ± 0.57	Good
Learning skills overall	3–5	5	4.59 ± 0.13	Good
Learning skills per item	3–5	5	4.40 ± 0.72	Good
11. The UCLA could increase the ability to assess duration, interval, and intensity in the latent phase				
12. The UCLA could increase the ability to assess duration, interval, and intensity in the active phase	4–5	5	4.60 ± 0.50	Good
13. The UCLA could increase the ability to assess duration, interval, and intensity in the transitional phase	4–5	5	4.63 ± 0.49	Good
14. The UCLA could increase comprehension and assessment of normal uterine contractions	4–5	5	4.73 ± 0.45	Good
Perceived self-confidence overall and per item	4–5	5	4.77 ± 0.43	Good
	4–5	5	4.77 ± 0.43	Good
15. Using the UCLA could help increase students' self-confidence and perception when assessing uterine contractions of real patients			4.77 ± 0.43	

Note. $N = 30$. Ranked of quality level, M ≥ 4 = good, M ≥ 3–3.9 = fair, M < 3 = poor.
Abbreviations. M, mean; SD, standard deviation; UCLA, uterine contraction learning aid.

Learning Aid was used successfully by nursing students in practicing the assessment of uterine contractions and the novel invention also increased their self-directed learning skills (Cura et al., 2020).

9.2. The comparison of experimental and control knowledge, attitude, and practice

The results revealed that the participants in the experimental group had a higher knowledge, attitude, and practice scores when assessing uterine contractions than the control group. This result was consistent with a recent study that showed how a novel delivery mechanism wheel could increase knowledge, attitude, and practice in delivery mechanism

Table 2
Participants' mean scores on knowledge, attitude and practice (KAP).

Participant evaluations	M ± SD	T	P-values
Knowledge of the assessment of uterine contractions			
Experimental group	18.03 ± 1.13	4.768	0.0001**
Control group	16.57 ± 1.25		
Attitudes toward the assessment of uterine contractions			
Experimental group	46.57 ± 2.74	0.188	0.852
Control group	46.43 ± 2.76		
Practices in the assessment of uterine contractions			
Experimental group	6.53 ± 0.78	3.630	0.001*
Control group	4.90 ± 2.34		

Notes. $N = 60$; Experimental group = 30; Control group = 30 *$p < 0.001$, **$p < 0.0001$.
Abbreviations. M, mean, SD, standard deviation.

assessments (Yimyam et al., 2018). Other researchers found that the model could increase nursing cadets' skills in fetal position assessment (Nunchai and Saengnual, 2018). A prominent scholar has stated that having real experience generates higher persistence of memory and skills in students compared to those without experience (Dale, 1969; Lee and Reeves, 2018). The current results revealed that there were no statistically significant differences in attitude scores in assessing uterine contractions across the two groups ($p < 0.001$). This result was consistent with the learning concept of Bloom, who indicated that the affective domain or attitude is a value, feeling, appreciation, belief, interest, or moral that may not occur immediately after an intervention like the Uterine Contraction Learning Aid (Bloom and Krathwohl, 1956; Forehand, 2005). Therefore, providing a specific use period for the Uterine Contraction Learning Aid in the maternal newborn nursing and midwifery practicum might not improve students' attitudes toward assessing uterine contractions. Further research is required to evaluate long term knowledge retention and clinical competence.

9.3. Study limitations

There were some limitations in this study. First, the schedule of practice in the Department of Maternal and Newborn Nursing and Midwifery was set prior to conducting the study. Limitations to the available timeslots for utilizing the Uterine Contraction Learning Aid may have caused some exhaustion in the study participants. Last, the Uterine Contraction Learning Aid needed to be used with the pregnancy model; therefore, without the pregnancy model, the Uterine Contraction Learning Aid could not function. However, the pregnancy model was a basic model commonly used in many nursing institutes. Moreover, the Uterine Contraction Learning Aid was a prototype, and it could be further produced.

10. Conclusion

Overall, the quality of the Uterine Contraction Learning Aid was good. In addition, the Uterine Contraction Learning Aid increased the knowledge, attitude, and practice values for uterine contraction assessment. This suggests that the Uterine Contraction Learning Aid could be used to help prepare inexperienced nursing students prior to providing service to mothers during the intrapartum period.

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Pornpimol Apartsakun Conceptualization, Methodology, Investigation, Data curation, Writing- Original draft preparation.
Sunee Kleebpan Conceptualization, Investigation, Writing- Original draft preparation.

Submission declaration and verification

I confirm that this article is not published elsewhere.

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None required - all images are owned by Pornpimol Apartsakun.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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