Provisionally accepted for publication

ORIGINAL ARTICLE

Shoulder dystocia simulation program: evaluation of learning from practical obstetric multi-professional training and its impact on patient outcomes

Claudio **Celentano** [1,2], Luigi **Ippoliti** [3], Maurizio **Rosati** [1,2], Barbara **Matarrelli** [4], Claudio **Crescini** [5], Claudio **Meloni** [6], Federico **Prefumo** [7]

1 Department of Obstetrics and Gynecology, Santo Spirito Hospital, Pescara, affiliated University G. d'Annunzio Chieti-Pescara, Italy

2 EASC, Santo Spirito Hospital, Pescara, Italy

3 Department of Economics, University G. d'Annunzio Chieti-Pescara, Italy

4 Department of Obstetrics and Gynecology, SS. Annunziata Hospital, Chieti, University G. d'Annunzio Chieti-Pescara, Italy

5 Obstetrics and Gynecology Unit, Humanitas University, Milan, Italy

6 Obstetrics and Gynecology Unit , San Giovanni di Dio Hospital, Florence, Italy

7 Obstetrics and Gynaecology Unit, IRCCS Istituto Giannina Gaslini, Genoa, Italy

[*]**Corresponding author:** Claudio **Celentano**, M.D. Department of Obstetrics and Gynecology, Santo Spirito Hospital Pescara, University "G. d'Annunzio" Chieti-Pescara, Italy, 65100Pescara, Italy.

Email: celentanoclaudio70@gmail.com.

Doi: 10.36129/jog.2025.208

ABSTRACT

Objective. Shoulder dystocia is one of the major leading cause of both maternal and neonatal morbidity and mortality. Simulation teaching has largely become a part of the training.

Materials and Methods. A questionnaire was administered to maternity staff who had attended a simulator training course. Participants were midwives, gynecologists, and residents. We used the four levels Kirkpatrick's Evaluation. The efficacy by participants' responses to three specific questions.

Results. 178 questionnaires were completed. An experience of shoulder dystocia before occurred to 87% specialists in obstetrics and gynecology, 82% midwives, and 56% residents. Within six months, 26 specialists, 20 midwives and 5 residents experienced a case of shoulder dystocia. From the exploratory analysis, it was found that 43 specialists encountered shoulder dystocia both before and after attending the course. The training course on solving shoulder dystocia demonstrated significant effectiveness (X^2 7.9354, p=0.004848). The model in the R environment suggests that training did not significantly enhance skills or confidence in managing shoulder dystocia, indicating the training course effective.

Conclusions. Shoulder dystocia is an unpredictable and unpreventable obstetric emergency with serious consequences. It is therefore mandatory for obstetricians and labor ward staff to be skilled in managing rare and potentially fatal emergencies. The present study, albeit based on individual training formation, involved different labor ward professionals such as obstetricians, residents, and midwives. The training course has proven to be effective, particularly for those without prior experience with shoulder dystocia. A national-wide program, represents a known way to improve outcomes in shoulder dystocia.

Key words

Mannequin; simulation training; trainees; vaginal delivery; shoulder dystocia.

Introduction

Although obstetric emergencies occur infrequently, the incidence of severe maternal morbidity and mortality is increasing [1]. Shoulder dystocia is one of the major leading cause of both maternal and neonatal morbidity and mortality, involving up to 3% of births [2]. High risk deliveries due to identified risk factors cannot really anticipate occurrence of this emergency [2-3]. In addition, shoulder dystocia is among the most common causes of medico-legal litigation against obstetrical providers [4]. Due to shoulder dystocia may occur without warning, regular training is necessary to retain skills in its management [5].

Simulation teaching has largely become a part of the training curricula for many obstetrics and gynecology residency programs all over the world, as simulation has shown promise in teaching and evaluating performance, and correlates positively with patient-related outcomes [6].

Many factors could affect whether training programs reach their outcomes [7-8]. The mainstay of implementing training programs is accurately assessing impact, learners' satisfaction, and meaningfulness of input and output [9-11]. One of the methods used to assess educational programs is Kirkpatrick's model [12].

The aim of the present study was to evaluate the impact of simulation-based shoulder dystocia program on learners. Kirckpatrick's evaluation model was used to demonstrate the effectiveness on the four levels of the model. The results level in Kirkpatrick's evaluation model was further avallate by comparing outcomes in shoulder dystocia resolution before and after training.

Research Design and Methods

Study design and participants

A questionnaire online was administered between May 2023 and October 2023 to maternity staff who had attended a simulator training course using the Italian Obstetric Emergencies group (GEO) format[13] at least 6 months before. Training session on low-fidelity mannequins (Sophie and Sophie's Mum Birth Simulator MODEL-med International pty. Ltd., PROMPT Birthing trainer Limbs and Things Ltd., Bristol, UK) were performed. Participants were midwives, gynecologists classified on the base of seniority, and residents. Participant data (sex, age, position, seniority, number of deliveries per year, and institutional cesarean section rate) were collected. (Table 1)

Questionnaires

The evaluation of the training followed a post-test research design using a Google Form online questionnaire. The questionnaire was drafted, revised and agreed on by the GEO Group (CC) to establish content validity.

Each questionnaire evaluated shoulder dystocia experience before the course, shoulder dystocia experience after the course, based on 6 items using a 5-point Likert scale, and an open question. All participants were enrolled at least 6 months after a course through an e-mail invitation to a Google Form questionnaire. The questionnaire was completed online; answers were recorded and analyzed after the end of recruiting time.

The study aimed to assess the effect of the simulation course on patient outcomes, performance of obstetric care teams in practice, and educational settings and trainees' experience.

We used the four levels Kirkpatrick's Evaluation model. Outcome assessed were: "patient care" expressed as overall reduction in maternal and fetal adverse outcomes in shoulder dystocia occurred before and after the course and within occupational qualification (Kirkpatrick level 4); and "performance in practice" expressed as increase in managing a shoulder dystocia event as first operator. "Perception of skill improvement" (Kirkpatrick level 1), "Fixing of checklist skills" (Kirkpatrick level 1), and "Improvement in identification skills" (Kirkpatrick level 3) were also analyzed separately.

All participants underwent questions related to information in Kirkpatrick model level one and two, whereas the last two levels were assessed to trainees with shoulder dystocia experience after the training course. Likert's scale values of 4 and 5 were considered as positive, 3 as neutral, and 1 and 2 values as negative.

Statistical Analysis

Statistical analysis was performed using IBM *SPSS* Statistics 24.0 (Armonk, NY) and lavaan package within the R environment [14]. Continuous variables were tested for normality and summary statistics were reported in terms of means and standard deviation (SD). Unless otherwise stated, inference was based on the statistical t-test, with a p-value of less than 0.05 considered statistically significant. For categorical variables organized in contingency tables, group comparisons were performed using either the Chi-square test or Fisher's exact test where appropriate

Statistical analysis of categorical variables with ordered values was also conducted using confirmatory factor analysis [15]. The primary aim of factor analysis was to elucidate the covariance relationships among observed variables by uncovering latent, unobservable factors. If variables within a particular group exhibit high correlations among themselves but demonstrate relatively small correlations with variables in other groups, it suggests that each group may represent a distinct underlying construct or factor responsible for the observed correlations. In this study, the factor model aims to estimate an underlying factor representing the general perceived efficacy of the attended course. This efficacy was measured by participants' responses to three specific questions on a 5-point Likert scale: 1) "Does simulation enhance the diagnosis of shoulder dystocia in daily life?"; 2) "Does simulation improve knowledge of protocols?"; and 3) "Does simulation facilitate prompt recognition of shoulder dystocia?".

From a statistical standpoint, we consider the *single-factor model*, which is specified as follows:

$$Y_1^* = \lambda_1 f + u_1$$
$$Y_2^* = \lambda_2 f + u_2$$
$$Y_3^* = \lambda_3 f + u_{3.}$$

In practice, the model involves the simple linear regression of a continuous variable Y_i^*, *i*=1,2,3, associated with the corresponding observed categorical variable, Y_i, on a single underlying latent variable, or common factor, *f*, representing the efficacy of the simulation teaching. The continuous variable, Y_i^*, is assumed to be the true measure for a given attitude underlying the ordered responses of Y_i, and it has a domain from - ∞ to ∞. For an ordinal variable Y_i with m_i categories (5 in our case), the relationship between the ordinal variable Y_i and the underlying continuous variable Y_i^*, is

$$Y_i = c \iff \tau_{c-1}^{(i)} < Y_i^* < \tau_c^{(i)}, \qquad c = 1,2,\cdots,m_i$$

where $\tau_0^{(i)} = -\infty$, $\tau_1^{(i)} < \tau_2^{(i)} \cdots < \tau_{m_i-1}^{(i)}$, $\tau_{m_i}^{(i)} = \infty$.

We note that the continuous variable Y_i^* is considered because the distances between categories (or Likert scale points) are unknown and in most cases unmeasurable. If we, however, use Muthén's view on the connection between ordinal and continuous variables for this type of data, then it is possible to estimate threshold parameters that can be used to estimate probabilities of two observed values on two ordinal variables [16].

The terms λ_1, λ_2, and λ_3, which are essentially regression coefficients are, in this context, known as *factor loadings*, and show how each variable, Y_i^*, depends on the common factor *f*. The terms u_1, u_2, and u_3 represent uncorrelated random disturbance terms and will have small variances if their associated observed variable is closely related to the underlying latent variable.

For our purposes, factor analysis enables dimensionality reduction and concisely summarizes the information from the three measured variables into a single latent variable or factor. This factor not only enhances the overall interpretation of relationships and patterns regarding interpretation, recall, and responsiveness in shoulder dystocia treatment, but also serves as effective variable for conducting exploratory analysis. By analysing the differences in factor scores among different groups, we can provide valuable insights into the variations in skills across various contexts and groups.

The model was estimated in the R environment using the package *lavaan* [17].

The study was conducted in accordance with the Declaration of Helsinki and was registered with www.clinicaltrials.gov. Since the participation was voluntary, the need for an ethical approval for this study was waived by the Local Ethics Committee.

Results

The questionnaire was sent to professionals via Google Forms: 178 completed. Demographic data are described in Table 1. An experience of shoulder dystocia before the course occurred to 59/68 (87%) specialists in obstetrics and gynecology, 75/92 (82%) midwives, and 10/18 residents (56%). Within six months, 26 specialists, 20 midwives and 5 residents experienced a case of shoulder dystocia.

None of the residents before and after course solved the event as first operator and in no cases adverse maternal and/or fetal outcome occurred.

32 midwives solved the shoulder dystocia as first operator before the course and 12 after (p= NS). Adverse outcomes occurred 5 times before and two times after (p= NS).

Among obstetrics and gynecology specialists, 38/59 (64%) and 21/27 (75%) events were faced directly by the operator, respectively before and after the course (Table 2). Table 2 describes events within Ob-Gyn specialists before and after courses.

From the exploratory analysis, it was found that 43 specialists encountered shoulder dystocia both before and after attending the course. The training course on solving shoulder dystocia demonstrated significant effectiveness (X^2 7.9354, p=0.004848). Initially, 24 out of these 43 specialists could solve shoulder dystocia independently. After the course, 20 of these 24 specialists retained their ability to handle the problem on their own, indicating that the course helped them maintain their competence. Additionally, the course had a notable impact on those who previously struggled with the issue. Among the 19 specialists who could not solve shoulder dystocia before the course, 8 were able to directly address the issue afterward. This improvement highlights the course's success in enhancing the skills of those less confident or experienced in managing shoulder dystocia. Overall, the results suggest that the training was beneficial not only in reinforcing the abilities of those already proficient but also in significantly improving the capabilities of those who initially lacked the necessary skills. This dual impact underscores the course's value in preparing medical specialists to effectively manage shoulder dystocia.

Shoulder dystocia maneuvers were recorded and described in Table 3a-c. No significant differences were described before and after course maneuvers within different professional positions.

The model in the R environment using the package *lavaan*[17] had an estimated factor loadings are $\hat{\lambda}_1 = 0.86$, $\hat{\lambda}_2 = 0.95$, and $\hat{\lambda}_3 = 0.81$, which denote the strength and direction of the relationship between each question and the common factor. Large values of the factor loadings indicate strong positive associations with the underlying efficacy factor. This suggests that groups of attendees exhibiting higher values of the common factor *f* are expected to receive the greatest benefit from the course. By analysing the distribution of the factor scores among the attendees distinguished by occupation (0=Resident, 1=Specialist, 2=Midwife) and shoulder dystocia experience (0=NO pre-course experience, 1= YES pre-course experience), the following plot indicates that regardless of prior experience, midwives consistently exhibit lower factor scores compared to specialists. (Figure 1)

This suggests that training courses did not significantly enhance their skills or confidence in managing shoulder dystocia. Specialists, particularly those without previous experience, demonstrate the highest scores. This indicates that the training course was highly effective for specialists, significantly boosting their proficiency and readiness to handle such cases. Residents' performance varies based on prior experience, with those lacking prior experience showing the greatest improvement.

Kirkpatrick level 1 results are plotted in Figure 2: 94% and 91% of questionnaires had a positive result within trainees with and without a previous experience of shoulder dystocia, respectively; 9% and 6% reported neutral results; none had a negative results on this topic.

Figure 3 similarly presents a positive result in experienced operators in 80%, 82%, and 85% for levels 2, 3, and 4, respectively. Neutral results were recorded in 19%, 16%, and 13%. Negative answers were recorded in 1%, 4%, and 2%, respectively.

Discussion

Shoulder dystocia is an unpredictable and unpreventable obstetric emergency with serious consequences [18]. The 5th Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) annual report described that in 66% of deaths due to shoulder dystocia, avoidable factors and different management strategies may have altered outcomes [19]. Therefore, obstetricians and labor ward staff must be skilled in managing rare and potentially fatal emergencies due to provided evidence on outcomes within trained professionals [20], and substandard care is common in adverse obstetric events [21]. Teamwork training to manage shoulder dystocia is expected to be better than individual training. The present study, albeit based on individual training formation, involved different labor ward professionals such as obstetricians, residents, and midwives.

The simulation training format based on low-fidelity mannequins, represents the simplest and cheapest scenario, and undoubtedly compares well with high-fidelity systems [22]; however, it may be biased by different facilitator approaches in teaching.

Another strength of our study is that a common teaching format [13] widespread all over the country, was used. A frontal lecture was always delivered, followed by simulation training using a low-fidelity mannequin repeated at least 3 to 4 times. The algorithm has a clear stepwise sequence of external and internal maneuvers following the diagnosis of shoulder dystocia [13].

No difference in operator solving the event within specialists, midwives and residents was recorded (Table 2). A significant difference was recorded for adverse outcome only for specialist operators before and after training (24% vs 0%, p=0.02). After the course a larger increase in young operator was recorded within specialists (2/38 vs 7/21, p=0.004). Independently pre and post courses resolutions were described in resolvers of shoulder dystocia (p=0.005). In the meantime, an amount of trainees depicted a positive association as non-resolvers. A larger group of specialists is needed due to identify risk factors related to this.

The ANOVA test, used to analyze the difference between the means of the latent factor among the groups, suggested that different maneuvers were not statistically different within roles and professional positions before and after course. The incidence of adverse outcomes, although different within Ob-Gyn specialists (20.3% vs 3.7% respectively before and after), was not different in the whole population (16.5% vs 13.8% respectively).

The training course has proven to be very effective for specialists and residents, particularly for those without prior experience with shoulder dystocia. The substantial improvement in their factor scores indicates a significant enhancement in their capabilities, which is crucial for improving patient outcomes in shoulder dystocia cases. The consistently low factor scores for midwives imply that the current training program may not adequately address their specific learning needs or that additional support and tailored training are necessary to enhance their skills. This could involve more practical sessions, targeted simulations, or focused mentorship programs to better equip midwives for shoulder dystocia scenarios. Given the observed improvements in residents' performance, especially among those without prior experience, it is evident that early and intensive training for residents is highly beneficial. Ensuring that residents receive comprehensive training early in their careers can build a strong foundation for their future practice.

Our questionnaire evaluated all levels of Kirkpatrick learning method of evaluation (ref Kirkpatrick 1996). Majority of population (above 80%) answered positively in all levels, reaching 91% and 94% for level 1 in population with and without previous experience.

In our dataset it is recorded a “catastrophic” shoulder dystocia [23] in which fetal death occurred after Zavanelli maneuver. As described in CESDI Report, shoulder dystocia could imply a severe adverse outcome such as fetal death [19].

Conclusion

Shoulder dystocia is one of the most unpredictable and unpreventable obstetric emergencies. Additional maneuvers are required, and operator skills training is mandatory. A national-wide program, although under voluntary admission, provided by GEO [13], represents a known way to improve maternal and fetal outcome in shoulder dystocia events [24].

This paper provides further evidence on validity of GEO program for management obstetric emergencies, and its effect on different birth attending professional roles. Larger data should be helpful for increasing the knowledge of different format of teaching. A further possibility for improvement could also be identified in the research of algorithms through AI and their application in tailored training, such as recently described for dystocic delivery [25].

Acknowledgments The authors thank GEO Group, ASL of Pescara, Asl of Toscana Centro, University of Chieti Pescara, and Eutylia group for recruiting and diffusion of online questionnaire.

Author contributions Authors contributed in conceptualization (CC, LI, BM, CC, CM, FP), data curation (CC, BM, CM, CC), formal analysis (CC, FP, LI, CM, CC), investigation (CC, BM, MR, CC, CM), methodology (BM, MR, CC), project administration (CC, FP, LI), supervision (CM, MR, FP, CC, CC), validation (MR, CM, FP, BM), visualization (CC, CC, FP, CM), writing – original draft (CC, BM, CM, FP, LI), writing – review & editing (LI, FP, CM, CC, CC).

Funding The study received no external funding

Study Registration The study was registered in the Current Controlled Trials Register (registration number NCT05921045).

Disclosure of interest The authors declare that they have no conflict of interest to disclose.

Ethics approval and consent to participate The study was conducted in accordance with the Declaration of Helsinki. Since the participation was voluntary, the need for an ethical approval for this study was waived by the Ethics Committee of the Medicine University of Chieti-Pescara.

Informed consent N/A

Data sharing N/A

References

1) Callaghan WM, Creanga AA, Kuklina EV. Severe morbidity among delivery and postpartum hospitalizations in the United States. Obstet Gynecol 2012;120:1029-36. doi: 10.1097/aog.0b013e31826d60c5.

2) Doumouchtsis SK, Arulkumaran S. Is it possible to reduce obstetrical brachial plexus palsy by optimal management of shoulder dystocia? Ann NY Acad Sci 2010;120:135-43. doi: 10.1111/j.1749-6632.2010.05655.x.

3) Gurewitsch ED, Allen RH. Reducing the risk of shoulder dystocia and associated brachial prexus injury. Obstet Gynecol Clin North Am 2011;38:247-69. doi: 10.1016/j.ogc.2011.02.015.

4) Mavroforou A, Koumantakis E, Michalodimitrakis E. Physichians' liability in obstetrics and gynecology practice. Med Law 2005;24:1-9. PMID: 15887609.

5) Anderson JE. Complications of labor and delivery: shoulder dystocia. Prim Care 2012;39:135-44. doi: 10.1016/j.pop.2011.12.002.

6) Cook DA, Hatala R, Brydges R, Zendejas B, Szostek JH, Wang AT, Erwin PJ, Hamstra SJ. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA 2011;306:978-988. doi: 10.1001/jama.2011.1234.

7) Ghaffari R, Ranjbarzadeh FS, Azar EF, et al. The analysis of learning styles and their relationship to academic achievement in medical students of basic sciences program. Res Dev Med Educ 2013;2:73-76. doi: 10.5681/rdme.2013.017.

8) Rezaee R, Moadeb N. Team-based learning: a new approach toward improving education. Acta Med Iranica 2016;54:678-682. PMID: 27888597.

9) Kojuri J, Amini M, Karimian Z, Dehghani MR, Saber M, Bazrafcan L, Ebrahimi S, Rezaee R. Needs assessment and evaluation of a short course to improve faculties teaching skills at a former World Health Organization regional teacher training center. J Adv Med Educ Prof 2015;3:1-8. PMID: 25587548.

10) Dennick R. Long-term retention of teaching skills after attending the Teaching Improvement Project: a longitudinal, self-evaluation study. Med Teach 2003;25:314-318. doi: 10.1080/0142159031000100436.

11) Wu YC, Hsieh LF, Lu JJ. What's the relationship between learning satisfaction and continuing learning intention? Procedia Soc Behav Sci 2015;191:2849-2854. doi: 10.1016/j.sbspro.2015.04.148.

12) Kirkpatrick DL, Kirkpatrick JD. Evaluating training programs: The four levels (3rd Edition). (2006) Berret-Koehler Publisher.

13) Ragusa A, Crescini C. Urgenze ed Emergenze in Sala Parto. (2016) 2nd edition. Piccin Publishers, pp303-322.

14) R Core Team. R: A language and environment for statistical computing [Computer software manual]. Vienna, Austria. 2023. Retrieved from https://www.R-project.org/

15) Muthén BO. A general structural equation model with dichotomous, ordered categorical, and continuous latent variable indicators. Psychometrika 1984;49:115–132. doi: 10.1007/BF02294210.

16) Muthén BO. Latent variable structural equation modeling with categorial data. Journal of Econometrics 1983;22: 43–65. doi: 10.1016/0304-4076(83)90093-3.

17) Gana K. and Broc G. Structural Equation Modeling with lavaan. (2019) Wiley.

18) Baiguini I, Osella E, Guglielmi D, Ferrante I, Sonzini M, Mazzoni G, Poletti de Chaurand V, Comerio C, Barresi S, Pasini B, Belloli S, Fucà A, Patanè L. Shoulder dystocia: a preventable obstetric emergency? Ital J Gynaecol Obstet 2023;35:90. doi: 10.36129/jog.2022.S89.

19) Rosser J. Confidential enquiry into stillbirths and deaths in infancy (CESDI). Highlights of 5th annual report – Part 3. Pract Midwife 1998;1:30-2. PMID: 10392156.

20) Kaijomaa M, Gisser M, Ayras O, Sten A, Grahn P. Impact of simulation training on the management of shoulder dystocia and incidence of permanent brachial plexus birth injury: An observational study. BJOG 2023;130:70-77. doi: 10.1111/1471-0528.17278.

21) Johansen LT, Braut GS, Acharya G, Andersen JF, Øian P. How common is substandard obstetric care in adverse events of birth asphyxia, shoulder dystocia and postpartum hemorrhage? Findings from an external inspection of Norvegian maternity units. Acta Obstet Gynecol Scand 2021;100:139-146. doi: 10:1111/aogs.13959.

22) Massoth C, Roder H, Ohlenburg H, Hessler M, Zarbock A, Popping DM, Wenk M. High-fidelity is not superior to low-fidelity simulation but leads to overconfidence in medical students. BMC Med Educ 2019;19:29. doi: 10.1186/s12909-019-1464-7.

23) Sandmire HF. Special communication Catastrophic shoulder dystocia. Int J Gynecol Obstet 2004;85:190-194. doi: 10.1018/j.ijgo.2003.09.004.

24) Royal College of Obstetricians & Gynaecologists. Shoulder Dystocia. Green-top Guidelines No. 42. 2nd Edition I March 2012.

25) Malvasi A, Malgieri LE, Cicinelli E, Vimercati A, D’Amato A, Dellino M, Trojano G, Difonzo T, Beck R, Tinelli A. Artificial Intelligence, Intrapartum Ultrasound and Dystocic Delivery: AIDA (Artificial Intelligence Dystocia Algorithm), a Promising Helping Decision Support System. J Imaging 2024;10:107. doi: 10.3390/jimaging10050107.

Table 1. Demographic Data

Characteristics	Number
Sex	
Male	35
Female	143
Age (yrs)	
25-30	18
31-35	27
36-40	33
41-45	28
46-50	13
51-55	18
>55	41
Seniority (yrs)	
0-2	21
3-5	30
6-10	8
>10	118
Occupation	
ObGyn resident	18
ObGyn specialist <5 yrs seniority	17
ObGyn specialist >5 yrs seniority	51
Midwife	92

Table 2. Shoulder dystocia events among Ob-Gyn specialists before and after course.

	Pre course		Post course		p value
	Solved by operator	Solved by others	Solved by operator	Solved by others	
Numbers	38	21	21	6	NS
Adverse outcomes	9*	3	0*	1	NS
Young specialist	2**	3	7**	1	NS
Sex (M/F)	26/12	11/10	12/9	1/5	NS

* p=0.0201

** p=0.0041

Table 3a. Shoulder dystocia maneuvers in Ob-Gyn Specialists (* adverse outcome).

Pre course			Post course	
	Solved by operator	Solved by others	Solved by operator	Solved by others
Mc Roberts/Walker	6*	2	5	10
Rubin I	4*	5	1	2*
Rubin II/Wood	9*	4	3	1
Jaquemier	15****	8	9*	2
Inverted Wood	2	2	3**	0
Upright/Gaskin	0	0	0	0
Zavanelli	0	0	0	0

Table 3b. Shoulder dystocia maneuvers in Ob-Gyn residents (* adverse outcome).

Pre course			Post course	
	Solved by operator	Solved by others	Solved by operator	Solved by others
Mc Roberts/Walker	0	4	0	0
Rubin I	0	1	0	0
Rubin II/Wood	0	3**	0	1*
Jaquemier	0	1	0	0
Inverted Wood	0	5**	0	1*
Upright/Gaskin	0	1	0	0
Zavanelli	0	0	0	0

Table 3c. Shoulder dystocia maneuvers in midwives (* adverse outcome).

Pre course	Post course

	Solved by operator	Solved by others	Solved by operator	Solved by others
Mc Roberts/Walker	10	9**	3	2*
Rubin I	4*	9	3	2
Rubin II/Wood	3	7**	1	0
Jaquemier	6*	11*	3	3*
Inverted Wood	6**	5**	2	1
Upright/Gaskin	2*	0	0	0
Zavanelli	0	1*	0	0

Figure 1. Box-plot distribution of factor score.

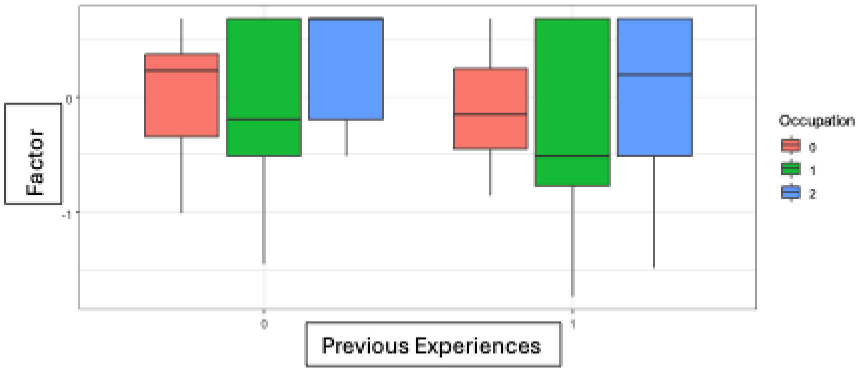

Figure 2. Box-plot Kirkpatrick level 1.

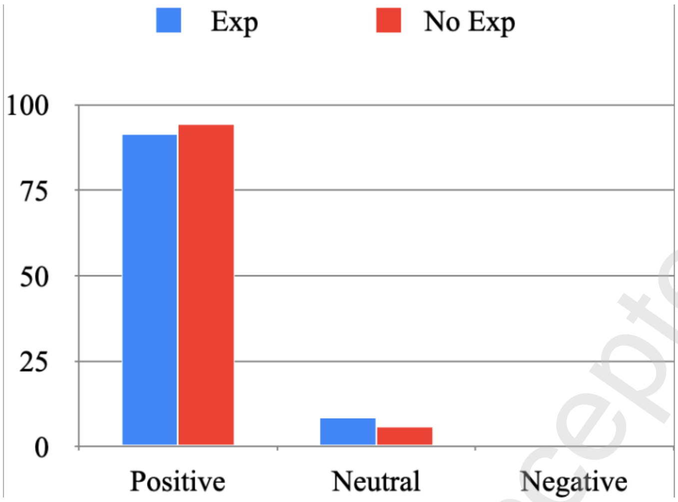

Figure 3. Box-plot Kirkpatrick level 2-3-4.