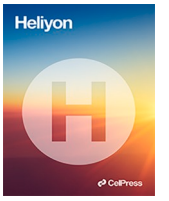
Heliyon 9 (2023) e21389

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



# Construction and evaluation of nursing-sensitive quality indicators for vaginal birth after cesarean: A Delphi study based on Chinese population

Xian Liu [a], Ling Liu [b], Junshuang Zhang [b], Xin Meng [b], Congcong Huang [b], Meng Zhang [b,*]

[a] Endoscopy Room, The Affiliated Hospital of Qingdao University, Qingdao, China
[b] Department of Obstetrics, The Affiliated Hospital of Qingdao University, Qingdao, China

ARTICLE INFO

*Keywords:*
Vaginal birth after cesarean
Nursing-sensitive quality indicators
Obstetrical nursing
Delphi method

ABSTRACT

*Aim:* To develop scientific, systematic and clinically applicable nursing-sensitive quality indicators for vaginal birth after cesarean in obstetrics, which provide a theoretical and clinical basis for monitoring and improving the nursing quality of vaginal birth after cesarean in China.
*Methods:* A modified Delphi-consensus technique was used in this study. Based on literature retrieval published between January 2012 and December 2022 and group discussion, the preliminary nursing-sensitive quality indicators were selected using a structural-process-outcome model. Then a questionnaire was designed on the preliminary indicators. The modified Delphi method was used to conduct two rounds of expert consultation among 26 hospitals in China. The survey data of experts' opinions were collected and analyzed to determine the final nursing-sensitive quality indicators. The importance of indicators, rationality of calculation formula and operability of data collection were analyzed and discussed.
*Results:* A total of 33 nursing-sensitive quality indicators were determined. The indicators were composed of 3-level ones, including 3 first-level indicators (structural, process and outcome indicators), 9 s-level ones and 33 third-level ones. The positive coefficients in the two rounds of expert consultation were 95.56 % and 97.67 %, respectively, and the authoritative coefficients were 0.88 and 0.94. The coefficients of variation ranged from 0.05 to 0.28.
*Conclusion:* The nursing-sensitive quality indicators were successfully developed using the modified Delphi method. The indicators are scientific, systematic and clinically operable, and play an important role in improving the nursing quality for pregnant women with vaginal birth after cesarean.

## 1. Introduction

The high rate of caesarean section (CS) has attracted great global attention of experts in obstetrics and gynecology. The prevalence of maternal mortality and morbidity is higher after CS than after vaginal birth. CS is associated with an increased risk of uterine rupture, abnormal placentation, ectopic pregnancy, stillbirth, and preterm birth. It can lead to short-term and long-term health

* Corresponding author.
*E-mail address:* zhangmeng_qd@126.com (M. Zhang).

https://doi.org/10.1016/j.heliyon.2023.e21389
Received 12 June 2023; Received in revised form 19 October 2023; Accepted 20 October 2023
Available online 21 October 2023

consequences [1–4]. Globally, the CS rate is high and increasing. The CS rate in 2015 (21.1 %) was nearly double of that in 2000 (12.1 %) [5]. Major clinical indications for CS include foetal distress, failure to progress in labor, previous cesarean sections, breech presentation, etc [6]. With the implementation of the 'two-child policy' in China, the number of women with a history of cesarean has greatly increased. It has maintained a high level of nearly 50 % and the pressure to reduce the CS rate is still high [7]. Vaginal Birth After Cesarean (VBAC) refers to a pregnant woman who has a history of CS and successfully undergoes a vaginal trial and completes a natural vaginal delivery or assisted vaginal delivery. As the technique progressed in obstetrics and gynecology, some studies found that planned vaginal birth after cesarean had positive effects on maternal and infant outcomes [8–10]. Increasing the VBAC rate can not only effectively reduce the rate of CS, but also reduce maternal and infant complications and optimize medical resources. The associated factors for VBAC have been explored extensively [11]. Some models were built to predict a successful VBAC [12–14]. However, many clinicians concerned that VBAC also had some risks, such as uterine rupture, endometritis, postpartum hemorrhage and fetal intrauterine hypoxia, increasing the mortality rate of mothers and infants [15]. It was reported that women with vaginal birth after cesarean section had an approximately 19-fold higher incidence in intrapartum stillbirths [16]. Therefore, obstetrician and midwifery should strengthen monitoring delivery, pay attention to pregnant women conscious symptoms and monitor vital signs regularly to ensure the safety of pregnant women [17].

Nursing-sensitive quality indicators (NSQIs) refer to a set of principle, procedure and assessment scales that are used to quantify the level of nursing quality and to assess nursing outcomes in clinical nursing practice [18,19]. NSQIs are defined as nursing-related structure, process and outcome indicators provided by nurses that are mainly affected by nursing work. Nursing-sensitive outcomes play an active role in the quality of care and cost-effectiveness of health systems. Tools for assessing nursing-sensitive outcomes are necessary to evaluate the nurses' contributions to the health of patients. NSQIs have been widely used to monitor nursing quality and evaluate nursing outcomes in clinical practice [20,21]. Establishing nursing-sensitive quality indicators (NSQIs) for vaginal birth after cesarean can significantly weaken the negative effects on maternal and infant outcomes, reduce maternal and infant complications, and improve nursing quality. Numerous studies have been done over the last two decades on the NSQIs [22–24]. In 1998, the American Nurses Association (ANA) issued guidelines of 10 nursing-sensitive quality indicators [25]. In 2004, the National Quality Forum (NQF) constructed 15 items of nursing-sensitive quality indicators. In 2016, the nursing center of China's Hospital Management Institute proposed 13 nursing-sensitive quality indicators. There were much research on general sensitive indicators of the whole hospital in China, and there were few reports on nursing-sensitive quality indicators of vaginal birth after cesarean in obstetrics. Therefore, it is urgent to construct nursing-sensitive quality indicators of VBAC, improve the nursing quality of VBAC, and reduce the potential risks of VBAC. Through a questionnaire survey and modified technique, this study developed grading nursing-sensitive quality indicators, analyzed the importance of indicator, rationality of calculation formula and operability of data collection, which improved the VBAC

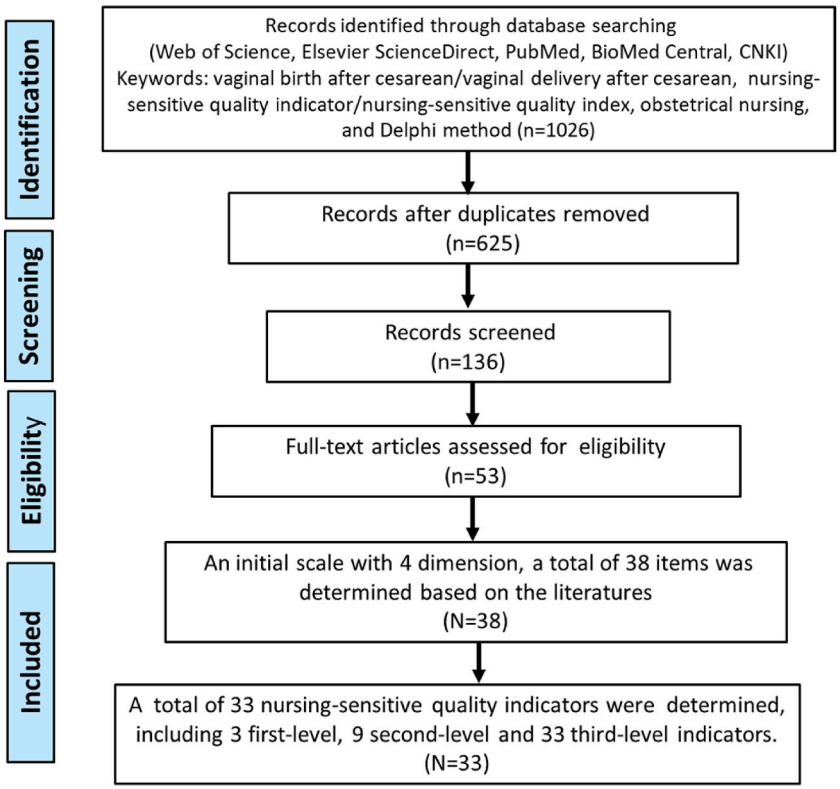



**Fig. 1.** Prisma flow diagram for searching literature and identifying nursing-sensitive quality indicators for VBAC.

nursing care quality, promoted the improvement of obstetric care quality and provided a basis for the formulation of relevant guides for hospitals. The object of the indicators is especially suitable for obstetric nurses to improve the nursing care quality.

## 2. Methods

### 2.1. Literature retrieval

Literature retrieval was conducted using the network resources in Qingdao University Library, including Web of Science, Elsevier ScienceDirect, BioMed Central, PubMed, and China National Knowledge Network (CNKI). Keywords were 'vaginal birth after cesarean' OR 'vaginal delivery after cesarean', AND 'nursing-sensitive quality indicator' OR 'nursing-sensitive quality index', AND 'obstetrical nursing' AND 'Delphi method'. Literature language: English or Chinese. The searches were limited to journal articles, including original research papers and review articles. A total of 1026 literatures were retrieved from the journals published between 2012 and 2022. The literature was screened according to the title, abstract and keywords. After the exclusion of 401 duplicates, 625 articles remained for further use. In the screening step, the criteria for exclusion/inclusion were used by reviewing titles and then reviewing the abstracts. Those publications were excluded that the full-text/abstracts were not available or the papers were not relevant to nursing-sensitive indicators. In addition, the studies were eliminated that were not published in a peer-reviewed journal (e.g. congress/symposium papers)/were not empirical such as letters, cases, reports, editorials, anecdotal. Ultimately, the use of a priori criteria resulted in 136 full-text publications being examined. After eligibility selection, a total of 53 valid papers were selected, which were managed with Endnote software. All nursing-sensitive quality indicators were collected and classified, and 33 nursing indicators were selected preliminarily. The prisma flow diagram for searching literature and identifying nursing-sensitive quality indicators for VBAC was shown in Fig. 1.

### 2.2. Research team

The research team was composed of **9** members, including 1 chief physician, 3 deputy chief nurses, 3 chief nurses and 2 nurses. The members had a full understanding of the general nursing-sensitive quality indicators and the specialized nursing care for vaginal birth after cesarean, which were widely used in the world. They were mainly responsible for discussing and analyzing the preliminary evidence-based nursing-sensitive quality indicators for vaginal birth after cesarean. They developed the Delphi expert survey questionnaire. After discussing and revising the data, they determined the expert survey questionnaire for the next round.

### 2.3. Delphi experts

Following the principles of representativeness, professional and voluntariness, the inclusion criteria of the Delphi panel experts in this study are: (1) from the first class domestic general hospital or maternity hospital; (2) with a bachelor degree or above (3) with an experience in obstetric nursing for more than 10 years or in nursing management for more than 5 years; (4) with high enthusiasm for the research, willing to answer the expert questionnaire and continue to participate in the next round survey. A total of 45 experts aged between 40 and 60 were selected from 10 hospitals in Shandong Province and 16 outside of Shandong province.

### 2.4. Delphi questionnaire design

Using the Donabedian structural-process-outcome theoretical model, the research team divided the nursing-sensitive quality indicators of VBAC into three categories: structural indicators, process ones and outcome ones [26–28]. According to a literature search and preliminary discussion, the first round expert questionnaire with 38 nursing-sensitive quality indicators was formed, including 3 first-level indicators, 9 s-level indicators and 38 third-level indicators. The questionnaire included three parts: introduction, body and general information of experts. (1) The introduction part mainly introduced the research purpose and background; (2) The body included the significance of indicators, the rationality of calculation formula and the operability of data collection. According to the Likert 5-level scoring method, the importance of indicators, the rationality of calculation formula and the operability of data collection method were scored, respectively. At the same time, a column for modification was supplied where experts could provide their suggestions, add or delete indicators and give reasons; (3) General information of experts was surveyed to determine the authority level of experts, including age, gender, position, title, judgment basis and familiarity of experts on indicators.

### 2.5. Delphi Survey

The research team conducted two rounds of Delphi expert survey. The Delphi technique is a structured communication technique that uses successive rounds of questionnaires and evaluation by a panel of experts to reach a consensus on proposed items. It can combine the opinions of a group of experts and is therefore widely used in the development of healthcare indicators [29–31]. The questionnaire was sent to the experts by email or wechat, who were invited to make positive suggestions. After the first round survey, data were collected. The research team classified the data, analyzed the data and sent the results to the experts as feedback. The indicators with the average agreement degree of importance of the items $\leq$70 % and/or coefficient of variation $\geq$0.3 were deleted, and the indicators with the rationality of calculation formula, the average agreement degree of data collection operability $\leq$70 % and/or coefficient of variation $\geq$0.3 were modified. For the items supplied by the experts, the research panel discussed and decided whether or

not add them to the second round questionnaire. Only participants who completed the first survey round were included in the second round. The second round questionnaire was sent to the experts for comments and opinions until the experts' opinions nearly reached a consensus.

### 2.6. Statistical analysis

Statistical software SPSS 19.0 was used for data processing and analysis. Descriptive analysis was expressed by means and standard deviation, while qualitative data were expressed by frequency and percentage. The expert positive coefficient was expressed by the questionnaire recovery rate. Authority coefficient (Cr) was expressed by the mean of expert familiarity (Ca) and judgment basis (Cs), Cr=(Ca + Cs)/2. The degree of coordination of expert opinions was reflected by the coefficient of variation (CV) and coefficient of coordination (W). The coefficient of variation reflected the fluctuation degree of the weight value assigned by the expert group to each indicator. The smaller the value, the better the coordination of expert prediction or evaluation opinions, and the general requirement was below 0.3. W reflected the coordination degree of all experts on all indicators, and the value ranged from 0 to 1 [32]. The larger the W, the higher the coordination degree of experts' opinions. 0.05 was considered statistically significant. The importance of sensitive indicators, the rationality of the calculation formula and the operability of data collection are the main contents of the coordination degree of two rounds of expert opinions, which reflects the coordination degree of expert opinions.

### 2.7. Ethical consideration

The study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University, China (QYFYWZLL27887). Informed written consent was obtained from all the experts, which was collected during the Delphi Survey.

## 3. Results

### 3.1. Expert positive coefficient, authority coefficient and coordination coefficient

Two rounds of expert survey were conducted in this study. A total of 45 copies of questionnaires were distributed in the first round, and 43 copies were recovered, with an effective recovery of 95.56 %. The authority coefficient of experts was 0.88, and the coordination degree (W) of expert opinions in sensitivity, rationality and feasibility were 0.302, 0.308 and 0.312, respectively. In the second round, 43 questionnaires were sent out, and 42 were recovered, with an effective recovery of 97.67 %. The expert authority coefficient was 0.94, and the coordination degree (W) of expert opinions in the three dimensions were 0.314, 0.324 and 0.328, respectively. The coordination degree of the two rounds of correspondence consultation was shown in Table 1.

### 3.2. Survey results of sensitive-nursing quality indicators

In the first round of survey, the experts agreed on the importance of 28 indicators among 38 initially selected indicators (4–5 points). The indicators with a higher degree of agreement were the rate of postpartum bleeding during vaginal delivery, the achieving ratio of midwife population, the occurrence ratio of neonatal birth injury, and the occurrence ratio of perineal wound infection during natural delivery. Twenty-five experts provided some constructive suggestions. The indicators with more feedback included the rate of accompanied delivery, the rate of delivery of a healthy newborn, the rate of hemorrhage after cesarean section, the rate of full-term newborns with Apgar score $\leq$7 in 1 min, and the occurrence rate of perineal wound infection during natural delivery.

After the first round of survey, "neonatal mortality" was deleted, and some indicators were added, including achievement ratio of patient identification, rate of nurse awareness of pregnant women's condition and qualified rate of neonatal resuscitation technology. In the second discussion, the research team analyzed the experts' opinions item by item, especially focusing on the aspects of nursing relevance, effectiveness of quality control, clinical operability, consistency with the names of indicators that have been included in the monitoring. In the second round of survey, experts greatly improved their recognition of most of the amended indicators on the importance of items, the rationality of calculation formulas and the operability of data collection. After the second round of survey, the item of "incidence of adverse outcomes of newborns" was deleted. Some indicators were added, including the incidence of perineal wound infection, the incidence of postpartum hemorrhage, the incidence of postpartum urinary retention and success rate of neonatal asphyxia rescue. The final nursing-sensitive quality indicator of VBAC was shown in Table 2, including 3 first-level indicators, 9 s-level indicators and 33 third-level indicators.

**Table 1**
Coordination degree of experts' opinions in the two round survey.

| round | sensitivity | | | rationality | | | operability | | |
|---|---|---|---|---|---|---|---|---|---|
| | W | $\chi$ [2] | P | W | $\chi$ [2] | P | W | $\chi$ [2] | P |
| 1 | 0.302 | 108.246 | <0.01 | 0.308 | 110.026 | <0.01 | 0.312 | 115.308 | <0.01 |
| 2 | 0.314 | 118.250 | <0.01 | 0.324 | 118.329 | <0.01 | 0.328 | 120.328 | <0.01 |

**Table 2**
Nursing sensitive quality indicators for VBAC.

| indicator | | Importance of item | | | | Rationality of formula | | | Feasibility of data collection | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator code | Indicator name | score ( x ± s ) | CV | degree of recognition | weight | score ( x ± s ) | CV | degree of recognition | score ( x ± s ) | CV | degree of recognition |
| I-1 | structure indicator | 4.66 ± 0.58 | 0.12 | 0.933 | 0.336 | 4.65 ± 0.87 | 0.22 | 0.880 | 4.63 ± 0.76 | 0.20 | 0.860 |
| II-1 | Organization and personnel | 4.68 ± 0.59 | 0.13 | 0.929 | 0.215 | 4.52 ± 1.19 | 0.26 | 0.830 | 4.46 ± 1.09 | 0.24 | 0.809 |
| III-1 | nurse-patient ratio | 4.70 ± 0.60 | 0.13 | 0.929 | 0.031 | 4.38 ± 1.16 | 0.26 | 0.847 | 4.46 ± 1.04 | 0.23 | 0.810 |
| III-2 | bed-nurse ratio | 4.68 + 0.58 | 0.12 | 0.929 | 0.031 | 4.38 ± 1.16 | 0.26 | 0.847 | 4.46 ± 1.04 | 0.23 | 0.810 |
| III-3 | doctor-nurse ratio | 4.68 ± 0.62 | 0.13 | 0.929 | 0.031 | 4.52 ± 1.28 | 0.28 | 0.833 | 4.54 ± 1.20 | 0.26 | 0.808 |
| III-4 | labor bed–midwife ratio | 4.71 ± 0.56 | 0.12 | 0.929 | 0.031 | 4.64 ± 1.28 | 0.28 | 0.833 | 4.48 ± 1.06 | 0.24 | 0.810 |
| III-5 | nursing hour/patient in 24 h | 4.70 ± 0.58 | 0.12 | 0.929 | 0.031 | 4.48 ± 1.16 | 0.26 | 0.840 | 4.45 ± 1.05 | 0.24 | 0.810 |
| III-6 | Configuration of different levels of nurses | 4.66 ± 0.64 | 0.14 | 0.929 | 0.030 | 4.56 ± 1.02 | 0.22 | 0.848 | 4.59 ± 1.02 | 0.22 | 0.812 |
| III-7 | each educational level of nurses | 4.65 ± 0.57 | 0.12 | 0.929 | 0.030 | 4.70 ± 1.30 | 0.28 | 0.833 | 4.23 ± 1.21 | 0.29 | 0.800 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-2 | training and education | 4.53 ± 0.81 | 0.18 | 0.882 | 0.059 | 4.69 ± 0.78 | 0.17 | 0.000 | 4.73 ± 0.65 | 0.14 | 0.943 |
| III-8 | training hours for per midwifery | 4.55 ± 0.82 | 0.18 | 0.882 | 0.030 | 4.69 ± 0.78 | 0.17 | 0.922 | 4.70 ± 0.76 | 0.16 | 0.943 |
| III-9 | passing rate of knowledge of baby-friendly hospital | 4.50 ± 0.80 | 0.18 | 0.882 | 0.029 | 4.69 ± 0.78 | 0.17 | 0.922 | 4.76 ± 0.54 | 0.11 | 0.943 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-3 | Materials and equipment 设备 | 4.74 ± 0.31 | 0.07 | 1.000 | 0.062 | 4.75 ± 0.64 | 0.14 | 0.976 | 4.70 ± 0.55 | 0.12 | 0.955 |
| III-10 | Rate of equipment in good condition | 4.90 ± 0.30 | 0.06 | 1.000 | 0.032 | 4.76 ± 0.68 | 0.15 | 0.976 | 4.71 ± 0.55 | 0.12 | 0.955 |
| III-11 | Standard rate of drug management | 4.58 ± 0.32 | 0.07 | 1.000 | 0.030 | 4.74 ± 0.59 | 0.12 | 0.976 | 4.68 ± 0.54 | 0.12 | 0.955 |
| | | | | 0.000 | #VALUE! | | | 0.000 | | | 0.000 |
| I-2 | Process indicators | 4.57 ± 0.71 | 0.16 | 0.916 | 0.269 | 4.71 ± 0.66 | 0.14 | 0.922 | 4.63 ± 0.71 | 0.15 | 0.930 |
| II-4 | Quality of midwifery | 4.69 ± 0.61 0.14 0.13 0.11 0.21 0.19 0.21 0.13 0.14 | 0.13 | 0.922 | 0.122 | 4.71 ± 0.55 | 0.12 | 0.922 | 4.60 ± 0.58 | 0.13 | 0.943 |
| III-12 | Awareness rate of nurses to puerpera | 4.88 ± 0.65 | 0.14 | 0.922 | 0.032 | 4.72 ± 0.50 | 0.11 | 0.922 | 4.60 ± 0.58 | 0.13 | 0.943 |

(*continued on next page*)

**Table 2** (*continued*)

| indicator | | Importance of item | | | | Rationality of formula | | | Feasibility of data collection | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator code | Indicator name | score ( x ± s ) | CV | degree of recognition | weight | score ( x ± s ) | CV | degree of recognition | score ( x ± s ) | CV | degree of recognition |
| III-13 | Accuracy of observation during labor | 4.60 ± 0.66 | 0.14 | 0.922 | 0.030 | 4.70 ± 0.62 | 0.13 | 0.922 | 4.61 ± 0.56 | 0.12 | 0.943 |
| III-14 | Qualified rate of birth records | 4.62 ± 0.60 | 0.13 | 0.922 | 0.030 | 4.68 ± 0.60 | 0.13 | 0.922 | 4.56 ± 0.62 | 0.14 | 0.943 |
| III-15 | Rate of fetal heart monitoring | 4.65 ± 0.51 | 0.11 | 0.922 | 0.030 | 4.73 ± 0.48 | 0.10 | 0.922 | 4.62 ± 0.55 | 0.12 | 0.943 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-5 | Nursing quality | 4.41 ± 0.91 | 0.20 | 0.905 | 0.087 | 4.69 ± 0.72 | 0.15 | 0.922 | 4.70 ± 0.75 | 0.16 | 0.943 |
| III-16 | Maternal health education awareness rate | 4.38 ± 0.93 | 0.21 | 0.905 | 0.029 | 4.70 ± 0.65 | 0.14 | 0.922 | 4.67 ± 0.76 | 0.16 | 0.943 |
| III-17 | fall risk management standard rate | 4.45 ± 0.86 | 0.19 | 0.905 | 0.029 | 4.68 ± 0.72 | 0.15 | 0.922 | 4.71 ± 0.74 | 0.16 | 0.943 |
| III-18 | Passing rate of pain assessment | 4.40 ± 0.94 | 0.21 | 0.905 | 0.029 | 4.69 ± 0.78 | 0.17 | 0.922 | 4.70 ± 0.74 | 0.16 | 0.943 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-6 | Operation quality | 4.61 ± 0.61 | 0.14 | 0.922 | 0.060 | 4.73 ± 0.71 | 0.15 | 0.922 | 4.59 ± 0.79 | 0.17 | 0.905 |
| III-19 | Midwifery skill operation pass rate | 4.50 ± 0.60 | 0.13 | 0.922 | 0.029 | 4.71 ± 0.65 | 0.14 | 0.922 | 4.61 ± 0.80 | 0.17 | 0.905 |
| III-20 | Qualified rate of neonatal resuscitation techniques | 4.72 ± 0.62 | 0.14 | 0.922 | 0.031 | 4.75 ± 0.77 | 0.16 | 0.922 | 4.57 ± 0.78 | 0.17 | 0.905 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| I-3 | Outcome indicators | 4.62 ± 0.62 0.977 0.977 0.977 0.977 | 0.13 | 0.946 | 0.396 | 4.80 ± 0.60 | 0.12 | 0.966 | 4.79 ± 0.62 | 0.13 | 0.949 |
| II-7 | Newborn health indicator | 4.69 ± 0.56 | 0.12 | 0.977 | 0.154 | 4.79 ± 0.58 | 0.12 | 0.977 | 4.79 ± 0.60 | 0.13 | 0.955 |
| III-21 | Mother-infant early contact/sucking rate | 4.53 ± 0.52 | 0.11 | 0.977 | 0.030 | 4.78 ± 0.68 | 0.14 | 0.977 | 4.70 ± 0.55 | 0.12 | 0.955 |
| III-22 | breastfeeding reaching the standard rate | 4.70 ± 0.50 | 0.11 | 0.977 | 0.031 | 4.79 ± 0.47 | 0.10 | 0.977 | 4.70 ± 0.55 | 0.12 | 0.955 |
| III-23 | Healthy newborn rate | 4.74 ± 0.70 | 0.15 | 0.977 | 0.031 | 4.84 ± 0.40 | 0.08 | 0.977 | 4.86 ± 0.66 | 0.13 | 0.955 |
| III2-4 | Incidence of neonatal injury | 4.76 ± 0.56 | 0.12 | 0.977 | 0.031 | 4.76 ± 0.68 | 0.15 | 0.977 | 4.76 ± 0.68 | 0.15 | 0.955 |
| III-25 | Success rate of neonatal asphyxia rescue | 4.72 ± 0.54 | 0.11 | 0.977 | 0.031 | 4.76 ± 0.68 | 0.15 | 0.977 | 4.94 ± 0.58 | 0.12 | 0.955 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-8 | Mother health indicator | 4.76 ± 0.52 | 0.11 | 0.972 | 0.155 | 4.84 ± 0.49 | 0.10 | 0.974 | 4.83 ± 0.53 | 0.11 | 0.959 |
| III-26 | Incidence of III/IV perineal laceration | 4.67 ± 0.64 | 0.14 | 0.953 | 0.031 | 4.90 ± 0.46 | 0.09 | 0.977 | 4.82 ± 0.56 | 0.12 | 0.955 |

(*continued on next page*)

**Table 2** (*continued*)

| indicator | | Importance of item | | | | Rationality of formula | | | Feasibility of data collection | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator code | Indicator name | score ( x ± s ) | CV | degree of recognition | weight | score ( x ± s ) | CV | degree of recognition | score ( x ± s ) | CV | degree of recognition |
| III-27 | Lateral perineal incision rate | 4.79 ± 0.44 | 0.09 | 0.977 | 0.031 | 4.87 ± 0.48 | 0.10 | 0.962 | 4.92 ± 0.34 | 0.07 | 0.976 |
| III-28 | Incidence of postpartum urinary retention | 4.80 ± 0.55 | 0.11 | 0.977 | 0.031 | 4.80 ± 0.55 | 0.11 | 0.977 | 4.74 ± 0.62 | 0.13 | 0.955 |
| III-29 | Incidence of perineal wound infection | 4.78 ± 0.49 | 0.10 | 0.977 | 0.031 | 4.85 ± 0.40 | 0.08 | 0.977 | 4.80 ± 0.65 | 0.14 | 0.955 |
| III-30 | Incidence of postpartum hemorrhage | 4.74 ± 0.50 | 0.10 | 0.977 | 0.031 | 4.80 ± 0.55 | 0.11 | 0.977 | 4.86 ± 0.46 | 0.10 | 0.955 |
| | | | | 0.000 | 0.000 | | | 0.000 | | | 0.000 |
| II-9 | Mother and infant health indicator | 4.42 ± 0.78 | 0.18 | 0.889 | .087 | 4.76 ± 0.73 | 0.15 | 0.934 | 4.74 ± 0.74 | 0.16 | 0.922 |
| III-31 | Rate of vaginal trial labor to cesarean | 4.10 ± 0.90 | 0.22 | 0.857 | 0.027 | 4.74 ± 0.76 | 0.16 | 0.928 | 4.72 ± 0.80 | 0.17 | 0.905 |
| III-32 | natural labor rate | 4.60 ± 0.60 | 0.13 | 0.929 | 0.030 | 4.78 ± 0.78 | 0.16 | 0.919 | 4.76 ± 0.78 | 0.16 | 0.905 |
| III-33 | unexpected delivery ratio | 4.56 ± 0.84 | 0.18 | 0.881 | 0.030 | 4.76 ± 0.66 | 0.14 | 0.955 | 4.74 ± 0.64 | 0.14 | 0.955 |

## 4. Discussion

### 4.1. Scientificity and reliability

This study adopted the "structural-process-outcome" theoretical model, which was the main theoretical basis of sensitive-nursing quality indicators in the world and was also widely used in China [33]. In this study, the authoritative databases at home and abroad were used for retrieval, and search terms in both Chinese and English were used to ensure completeness and avoid duplication. The grading nursing-sensitive quality indicator was preliminarily designed. Meanwhile, two rounds of expert surveys were conducted using the modified Delphi method to determine the nursing-sensitive quality indicators. Therefore, the established sensitive indicators are scientific. A total of 45 experts who were consulted by the Delphi technique came from 26 top-grade hospitals in 10 provinces or autonomous regions within and outside Shandong Province. All the experts were obstetrics and gynecology physicians, midwifery, senior nurses or nursing management faculty, with 5~35 years' work experience, 33 of them (74 %) with master or doctor's degrees, 34 of them (76 %) with associate professor or professor titles. The expert positive coefficient in the two rounds survey was 95.56 % and 97.67 %, respectively, indicating that the experts had a high participation enthusiasm. The authority coefficients were 0.88 and 0.94, respectively, and the coefficient of variation ranged from 0.05 to 0.28, indicating a high degree of expert opinion coordination. Therefore, the constructed nursing-sensitive quality indicators of vaginal birth after cesarean section are reliable.

### 4.2. Content analysis of indicators

#### 4.2.1. Structural indicators

The structural indicators refer to the relatively stable medical support environment, including the indicators related to the allocation of medical human resources and organizational structure. The structural indicators included three secondary indicators: organization and personnel, training and education, and materials and equipment. This study showed that the allocation of nursing human resources had a direct impact on nursing outcomes [34]. The bed-to-nurse ratio reflects the matching relationship between beds and nurses. A reasonable bed-to-nurse ratio can guarantee the basic nursing staff of bed-to-nurse unit, meet the needs of patients' nursing service, and maximize the benefits of nursing resource application. Therefore, the nurse-patient ratio and bed-care ratio become important sensitive indicators. The organization of the delivery room and potential understaffing may significantly affect the possibility to adopt one-to-one midwifery assistance and influence the obstetric outcomes during delivery. During a few years after the two-child policy was implemented, the number of women giving birth had exploded. The potential midwifery and nurses were insufficient, which limited the adopt of one-to-one midwifery assistance. The pregnant women would feel nervous during delivery. After the birth peak of second child, the nurse-patient ratio recovered and became balance. It increases the possibility to adopt one-to-one midwifery assistance and leads to positive outcomes during delivery. In the training and education indicators, experts believe that the pass rate of VBAC theoretical knowledge test and the pass rate of operation skill test, are two important indicators. If

the nurses have a good understanding of the VBAC, they can be fully aware of its possible risks and take appropriate measures to deal with the adverse events, such as postpartum hemorrhage and other uncertain emergencies.

#### 4.2.2. Process indicators

There are 17 three-level process sensitive indicators. They mainly include the pass rate of basic inpatient care quality, the pass rate of grading nursing, the pass rate of perioperative care quality, the pass rate of critical patient care, the pass rate of primary nurses' familiarity to the patient's condition and the nursing implementation, the qualified rate of admission health education, the pass rate of nursing documents, the pass rate of rescue work, the pass rate of patient identification, the pass rate of critical patient handover quality, the pass rate of pain care quality, and the pass rate of urinary tract infection prevention. Experts believe that patient identification is the first and most important one in nursing work. Mistaken identifications are prone to cause medical errors. The United States and China have included "patient identification" as the first item in their patient safety goals. Therefore, experts suggest adding the sensitive indicator of "pass rate of patient identification". At the same time, experts also advise to add the sensitive indicator of "pass rate of neonatal resuscitation technology" because there is a risk of asphyxia in newborns after caesarean section. Strengthening neonatal resuscitation technology training can significantly improve the success rate of neonatal rescue, and the importance score of this indicator item is 4.72 points. Furthermore, "awareness rate of chief nurses to pregnant women's condition" is an important sensitive indicator, which is related to the nursing staff to provide targeted nursing measures to patients. Therefore, it is recommended to add this process indicator.

#### 4.2.3. Outcome indicators

*4.2.3.1. Maternal health indicators.* Maternal and newborn mortality is the main indicator to measure the quality of obstetric care [35]. In 2014, the maternal mortality rate in China was 21.7 per 100,000, which decreased by 75.6 % compared with 88.8/100,000 in 1990 [36]. It lacks sensitivity to evaluate the nursing quality using an indicator with an extremely low probability. Experts recommend that maternal and neonatal mortality be removed from the sensitive indicator. Postpartum hemorrhage is an important factor leading to maternal morbidity and mortality, and postpartum hemorrhage is the main adverse pregnancy outcome of vaginal birth after cesarean section. Therefore, the experts advice to take following items as sensitive nursing indicators, including the rate of lateral perineal resection, the incidence of grade III/IV perineal laceration, the incidence of perineal wound infection, and the incidence of uterine rupture. Experts suggest to add some indicators, such as the incidence of postpartum hemorrhage, perineal wound infection, and postpartum urinary retention. Weak contraction, placental factors, soft birth canal injury are easy to lead to postpartum hemorrhage, perineal wound infection, and postpartum urinary retention.

*4.2.3.2. Newborn health indicators.* As for newborn health indicators, prolonged labor and fetal distress are the main influencing factors that lead to vaginal trial delivery to cesarean section. However, cesarean after a trial of labor is easy to lead some adverse consequences, such as maternal organ adhesion, postpartum bleeding, infection or newborn complications. Therefore, the indicators below significantly affected the newborn health, including the rate of early mother and infant touch/early sucking, rate of exclusive breastfeeding during hospitalization, rate of healthy newborns, rate of neonatal birth injury, and rate of neonatal asphyxia [37]. Neonatal asphyxia is an important cause of neonatal death. The rate of neonatal asphyxia is mainly monitored by the Apgar score system 1 min and 5 min after birth [38]. If the score is less than 3, the probability of neonatal death will be greatly increased. Therefore, experts suggest adding the sensitive indicator of "success rate of neonatal asphyxia rescue". According to expert opinion, the indicator of "incidence of neonatal adverse outcomes" is excluded because the indicator involves a wide range, the meaning or concept is not clear, and the severity of adverse results is different. The operability of this indicator is not high and it cannot be used to effectively evaluate the nursing quality. In addition, this indicator is duplicate with other ones, such as "III/IV grade perineal laceration rate" and "neonatal birth injury rate". Furthermore, although the indicators of "maternal mortality rate" and "neonatal mortality rate" are important, they are very low in China and other developed countries. If they are used to evaluate the quality of obstetric care, they lack sensitivity. So they are recommended to be deleted.

### 4.3. Strengths and limitations

There are some obvious strengths to this study. First of all, this study especially focuses on nursing-sensitive quality indicators for pregnant women of vaginal birth after cesarean, other than for the general pregnant women, which can significantly improve the nursing quality and the health of pregnant women and newborns. In addition, the modified Delphi technique ensured the reliability and validity of the indicators. Last but not least, the positive coefficients in the two rounds of expert survey and the authoritative coefficients were higher, which are especially suitable for obstetric nurses to improve the nursing care quality. However, there are still a few limitations to this study. Probably it still cannot represent the whole situation of the whole country because of the huge area of China. The views of experts included Delphi panel may differ from those of experts who declined participation. Because experts evaluate nursing-sensitive quality indicators according to their knowledge and experience, it is inevitable that there are subjective factors. Second, the data are obtained from the Chinese population and the generalization of our findings to other cultural populations needs further assessment. Third, no evaluation was provided to examine the validity and reliability of the nursing-sensitive quality indicators for VBAC in this study. Therefore, we should take into account the imbalance between urban and rural areas, improve the representativeness of experts, and minimize the influence of subjective factors in future research.

## 5. Conclusions

In this study, a total of 33 nursing-sensitive quality indicators were constructed based on the structural-process-outcome theoretical model and the modified Delphi method. The indicators were composed of 3-level ones, including 3 first-level indicators (structural, procedural and outcome indicators), 9 s-level ones and 33 third-level ones. The positive coefficients in the two rounds of expert consultation were 95.56 % and 97.67 %, respectively and the authoritative coefficients were 0.88 and 0.94. The coefficients of variation ranged from 0.05 to 0.28. The indicators provided a scientific basis for drawing up a nursing plan for vaginal birth after cesarean section and evaluating the nursing implementation effect. It can improve the nursing quality of VBAC, reduce the occurrence of adverse events of VBAC, and improve the overall quality of obstetric care. The sensitive-nursing grading indicators are scientific, systematic and practical, and can be popularized in obstetric departments across the country, provide a solid basis for building national standards for sensitive-nursing quality indicators for VBAC, and accelerate constructing informatization and standardization process of sensitive indicators of obstetric care. The actual clinical implication of this study was that the indicators were especially suitable for obstetric nurses to improve the nursing care quality. The primary findings of our study indicated the indicators were applicable and were easy to us in clinic. The study overcame the disadvantages of some previous indicators of duplicate, ambiguous and hard to apply.

## Ethics statement

The study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University, China (QYFYWZLL27887).

## Funding statement

The project was supported by Youth Foundation of the Affiliated Hospital of Qingdao University (QDYFQN202102027).

## Data availability statement

Data will be made available on request.

## CRediT authorship contribution statement

**Xian Liu:** Conceptualization, Investigation, Writing – original draft, Writing – review & editing. **Ling Liu:** Data curation, Investigation, Writing – original draft. **Junshuang Zhang:** Data curation, Investigation, Writing – original draft. **Xin Meng:** Data curation, Investigation, Methodology, Software. **Congcong Huang:** Data curation, Investigation, Methodology, Software. **Meng Zhang:** Conceptualization, Project administration, Supervision, Writing – original draft, Writing – review & editing.

## 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.

## Acknowledgements

The authors thank all the experts who participated in this investigation. We also acknowledge the Affiliated Hospital of Qingdao University for funding this study (QDYFQN202102027).

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e21389.

## References

[1] J. Sandall, R.M. Tribe, L. Avery, G. Mola, G.H.A. Visser, C.S.E. Homer, et al., Short-term and long-term effects of caesarean section on the health of women and children, Lancet 392 (10155) (2018) 1349–1357.
[2] A.M. Bruno, A.A. Allshouse, T.D. Metz, Trends in attempted and successful trial of labor after cesarean delivery in the United States from 2010 to 2020, Obstet. Gynecol. 141 (1) (2023) 173–175.
[3] K. Dahlquist, A. Stuart, K. Kallen, Planned cesarean section versus planned vaginal delivery among women without formal medical indication for planned cesarean section: a retrospective cohort study of maternal short-term complications, Acta Obstet. Gynecol. Scand. 101 (9) (2022) 1026–1032.
[4] D. Davis, C. S Homer, D. Clack, S. Turkmani, M. Foureur, Choosing vaginal birth after caesarean section: motivating factors, Midwifery 88 (2020), 102766.
[5] T. Boerma, C. Ronsmans, D.Y. Melesse, A.J. Barros, F.C. Barros, L. Juan, et al., Global epidemiology of use of and disparities in caesarean sections, Lancet 392 (10155) (2018) 1341–1348.
[6] V. Bam, A.Y. Lomotey, A. Kusi-Amponsah, H.I. Budu, G. Mireku, Factors influencing decision-making to accept elective caesarean section: a descriptive cross-sectional study, Heliyon 7 (2021) (2021), e07755.

[7] D. Tang, A. Laporte, X. Gao, P.C. Coyte, The effect of the two-child policy on cesarean section in China: identification using difference-in-differences techniques, Midwifery 107 (2022), 103260.
[8] A.P.B. No, Summary: vaginal birth after cesarean delivery, Obstet. Gynecol. 133 (2) (2019) 393–395, 205.
[9] K.E. Fitzpatrick, M.A. Quigley, J.J. Kurinczuk, Planned mode of birth after previous cesarean section: a structured review of the evidence on the associated outcomes for women and their children in high-income setting, Front. Med. 9 (2022), 920647.
[10] W.A. Grobman, G. Sandoval, M.M. Rice, J.L. Bailit, S.P. Chauhan, M.M. Costantine, et al., Prediction of vaginal birth after cesarean delivery in term gestations: a calculator without race and ethnicity, Am. J. Obstet. Gynecol. 225 (6) (2021) 664, e1-. e7.
[11] Y. Girma, Z. Menlkalew, A. Destaw, Vaginal delivery after caesarean section and its associated factors in mizan tepi university teaching hospital, southwest Ethiopia, Heliyon 7 (11) (2021), e08276.
[12] M. Lipschuetz, J. Guedalia, A. Rottenstreich, M.N. Persky, S.M. Cohen, D. Kabiri, et al., Prediction of vaginal birth after cesarean deliveries using machine learning, Am. J. Obstet. Gynecol. 222 (6) (2020) 613, e1-. e12.
[13] C.L. Wollmann, K.D. Hart, C. Liu, A.B. Caughey, O. Stephansson, J.M. Snowden, Predicting vaginal birth after previous cesarean: using machine-learning models and a population-based cohort in Sweden, Acta Obstet. Gynecol. Scand. 100 (3) (2021) 513–520.
[14] N. Black, I. Henderson, B.H. Al Wattar, S. Quenby, Predictive models for estimating the probability of successful vaginal birth after cesarean delivery A systematic review, Obstet. Gynecol. 140 (5) (2022) 821–841.
[15] B. Sabol, M.A. Denman, J.M. Guise, Vaginal birth after cesarean: an effective method to reduce cesarean, Clin. Obstet. Gynecol. 58 (2) (2015) 309–319.
[16] B. Deng, Y. Li, J.Y. Chen, J. Guo, J. Tan, Y. Yang, et al., Prediction models of vaginal birth after cesarean delivery: a systematic review, Int. J. Nurs. Stud. 135 (2022), 104359.
[17] O. Vikhareva, E. Nedopekina, K. Kristensen, C. Dahlbäck, M. Pihlsgård, G.S. Rickle, et al., Strategies to increase the rate of vaginal deliveries after cesarean without negative impact on outcomes, Midwifery 106 (2022), 103247.
[18] D. Koch, A. Kutz, A. Conca, J. Wenke, P. Schuetz, B. Mueller, The relevance, feasibility and benchmarking of nursing quality indicators: a Delphi study, J. Adv. Nurs. 76 (12) (2020) 3483–3494.
[19] L. Luo, L.Q. Wang, M. Zhang, B.Z. Liao, Application of obstetric nursing-sensitive quality indicators in continuous quality improvement, Am. J. Tourism Res. 14 (1) (2022) 643–655.
[20] Z.Y. Shen, W. Qin, L. Zhu, Y. Lin, H.X. Ling, Y.X. Zhang, Construction of nursing-sensitive quality indicators for cardiac catheterisation: a Delphi study and an analytic hierarchy process, J. Clin. Nurs. 31 (19–20) (2022) 2821–2838.
[21] E. Schenk, S. Johnson, Nurse-sensitive environmental indicators: a qualitative study, J. Nurs. Manag. 30 (8) (2022) 4378–4386.
[22] F. Murphy, O. Doody, R. Lyons, A. Gallen, M. Nolan, A. Killeen, et al., The development of nursing quality care process metrics and indicators for use in older persons care settings: a delphi-consensus study, J. Adv. Nurs. 75 (12) (2019) 3471–3484.
[23] B. Oner, F.D. Zengul, N. Oner, N.V. Ivankova, A. Karadag, P.A. Patrician, Nursing-sensitive indicators for nursing care: a systematic review (1997-2017), Nursing Open 8 (3) (2021) 1005–1022.
[24] N.G. Amatt, T.C. Marufu, R. Boardman, L. Reilly, J.C. Manning, Pediatric nurse-sensitive outcomes: a systematic review of international literature, Int. Nurs. Rev. 70 (2) (2023) 160–174.
[25] M. Zhang, W. Chen, C. Liu, J. Sui, D. Wang, Y. Wang, et al., Nursing-sensitive quality indicators for pernicious placenta previa in obstetrics: a Delphi study based across Chinese institutions, Nursing Open 8 (6) (2021) 3461–3468.
[26] C.E. Sullivan, S.W. Day, N. Ivankova, A. Markaki, P.A. Patrician, W. Landier, Establishing nursing-sensitive quality indicators for pediatric oncology: an international mixed methods Delphi study, J. Nurs. Scholarsh. 55 (1) (2023) 388–400.
[27] D. McIntyre, F. Coyer, A. Bonner, Identifying nurse sensitive indicators specific to haemodialysis nursing: a Delphi approach, Collegian 27 (1) (2020) 75–81.
[28] G. Kuang, X. Meng, Y. Wang, R. Xu, M. Zhang, Development and psychometric evaluation of self-management scale for pregnant woman with gestational diabetes mellitus in China, Nursing Open 9 (3) (2022) 1757–1765.
[29] M. Zhang, M. Liu, D. Wang, Y. Wang, W. Zhang, H. Yang, et al., Development of a risk assessment scale for perinatal venous thromboembolism in Chinese women using a Delphi-AHP approach, BMC Pregnancy Childbirth 22 (1) (2022) 426.
[30] F. Murphy, O. Doody, R. Lyons, A. Gallen, M. Nolan, A. Killeen, et al., The development of nursing quality care process metrics and indicators for use in older persons care settings: a Delphi-consensus study, J. Adv. Nurs. 75 (12) (2019) 3471–3484.
[31] M. Giltenane, A. Sheridan, T. Kroll, K. Frazer, Identification of quality indicators of public health nursing practice:“modified Delphi” approach, Publ. Health Nurs. 39 (1) (2022) 214–228.
[32] M. Zhang, W. Zhang, H. Yang, J. Zhang, Q. Li, R. Xu, et al., Design and evaluation of maternal early warning system to reduce preventable maternal mortality in pregnancy and puerperium for high-risk women in China, Midwifery 112 (2022), 103392.
[33] L. Heslop, S. Lu, X. Xu, Nursing-sensitive indicators: a concept analysis, J. Adv. Nurs. 70 (11) (2014) 2469–2482.
[34] L.Y. Turner, P. Griffiths, E. Kitson-Reynolds, Midwifery and nurse staffing of inpatient maternity services : a systematic scoping review of associations with outcomes and quality of care, Midwifery 103 (2021), 103118.
[35] M.R.C. Fabbro, M. Wernet, N.G. Baraldi, D.C.B. Claro, Salim NR. Jamile, B.G.A. Souto, et al., Antenatal care as a risk factor for caesarean section: a case study in Brazil, BMC Pregnancy Childbirth 22 (1) (2022) 1–12.
[36] C. Feng, Effects of new nursing model on reducing the rate of cesarean delivery in primiparas, Chinese J. Modern Nur. 25 (8) (2019) 1033–1035.
[37] V. Saraswathi, S. Kathrin, M.D. Marian, D. Eugene, C. Renee, C. Melissa, et al., Mapping integration of midwives across the United States: impact on access, equity, and outcomes, PLoS One 13 (2) (2018), e0192523.
[38] F. Li, T. Wu, X. Lei, Z. Hao, M. Meng, J. Zhang, et al., The apgar score and infant mortality, PLoS One 8 (7) (2013), e69072.