

Effect of a Midwife-led Continuity of Care Model on Complications following Vaginal Delivery and Maternal Satisfaction with Childbirth: A Controlled Study

Wenming LU

Ningbo University Affiliated Hospital

Sumengdie Li

Ningbo University Affiliated Hospital

Yanwei Yu

214445026@qq.com

Ningbo University Affiliated Hospital

Hongling Xie

Ningbo University Affiliated Hospital

Sangsang Huang

Ningbo University Affiliated Hospital

Chunbo Mao

Ningbo University Affiliated Hospital

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Abstract

Objective

To evaluate the effect of a midwife-led continuity of care model on complications following vaginal delivery and maternal satisfaction with childbirth.

Methods

In this controlled study design, participants were divided into two groups. The control group included parturients who received routine midwifery care and underwent vaginal delivery at our hospital from April 2022 to March 2023. The experimental group consisted of pregnant and puerperal women who were provided with midwife-led continuity based on the scheme in the control group at our hospital from April 2024 to March 2025. Inter-group comparisons were performed focusing on baseline characteristics, delivery outcomes, incidence of common complications following vaginal delivery, labor pain status, and maternal satisfaction with childbirth.

Results

Inter-group comparison showed a statistically significant difference in the mode of delivery ($P < 0.05$). Regarding common complications, the experimental group had significantly lower incidence of postpartum hemorrhage (3.7% vs 9.2%) and cervical laceration (6.4% vs 12.1%) than those in the control group (both $P < 0.05$), while no statistically significant inter-group differences were found in other complications ($P > 0.05$). Meanwhile, the experimental group had significantly higher rates of doula accompaniment and neuraxial labor analgesia, as well as significantly higher proportions of women reporting excellent or good pain relief than those in the control group (all $P < 0.05$). Further inter-group comparison revealed significantly higher maternal satisfaction with childbirth in the experimental group ($P < 0.05$), but no statistically significant differences in the incidence rates of adverse events and complaints (both $P > 0.05$).

Conclusion

The midwife-led continuity of care model can reduce the incidence of postpartum hemorrhage and cervical laceration, improve labor pain experience, and enhance maternal satisfaction with childbirth in parturients undergoing vaginal delivery. It is of positive significance for improving the quality of nursing care in the delivery room.

Trial registration:

Introduction

The global fertility rate has shown a continuous downward trend in recent decades. As estimated by the Institute for Health Metrics and Evaluation at the University of Washington, the overall fertility rate globally in 2021 was 2.23, approaching the replacement level of 2.1. The global fertility rate declined by > 50% between 1950 and 2021. Meanwhile, in 2021, 110 (54%) of 204 countries and regions worldwide had a fertility rate below the replacement level, and it is projected that 76% of countries and regions worldwide will have a fertility rate below the replacement level by 2050. Furthermore, the mean age at childbearing has continued to rise along with the decline in fertility rate. In high-income regions (Europe, North America, Australia, and New Zealand), nearly 60% of newborns are born to mothers aged over 30 years, coupled with a significant increase in the proportion of women of advanced maternal age (≥ 35 years) [1, 2]. The rising age at childbearing has led to an upward trend in the individual risk of complications related to vaginal delivery [3], a hot-spot in the field of obstetric quality improvement. Notably, the connotation of maternal health goes far beyond reducing the incidence of complications. As emphasized by the World Health Organization, high-quality maternal health care should also provide a positive childbirth experience, in addition to ensuring maternal and infant safety [4].

China faces a similar challenge. In 2021, the *Maternal and Child Safety Action Improvement Plan (2021–2025)* was issued by the National Health Commission of the People's Republic of China, aiming at enhancing maternal safety and improving childbirth experience [5]. The main actions include: improving the level of pregnancy risk prevention, enhancing the treatment capacity for critical and severe obstetric cases, upgrading the level of quality and safety management, strengthening the service capacity of maternal and child specialty, and increasing maternal satisfaction with delivery services. "To reduce the incidence of complications following vaginal delivery" has been listed as one of Ten Goals of National Medical Quality and Safety Improvement for several consecutive years [6, 7]. However, under the background of policy promotion, the obstetric service model in China is facing severe challenges and practical dilemmas. According to the report of the National Hospital Quality Monitoring System, the incidence of complications following vaginal delivery in China has risen from 13.4% in 2016 to 18.7% in 2020, which are dominated by obstetric laceration and postpartum hemorrhage [8, 9]. Therefore, in the implementation of the traditional service model, there are severe challenges in coping with the increasingly complicated health status of pregnant and puerperal women. Simultaneously, with increasing attention attached to childbirth experience, pregnant and puerperal women are no longer satisfied with routine prenatal examination and delivery, but also hope to receive comprehensive services such as emotional support and respectful communication [10]. In mainland China, with regard to the major delivery mode, midwives first engage with pregnant women during labor, and then provide communication, guidance, and delivery assistance within a short period of time. While leveraging the professional expertise of midwives, this model may restrict midwives to the single stage of labor, making it impossible to deliver continuous care spanning the antenatal, intrapartum, and postpartum periods. However, such fragmented service can neither fully leverage the core role of midwives in perinatal care,

nor address the underlying needs of pregnant and puerperal women for continuous and personalized services. As a result, it may be inapplicable when addressing the emerging demands of pregnant and puerperal women for a higher-quality service environment and more comprehensive service content. It highlights an urgent need for transforming the management model and updating the service philosophy. To be specific, it necessitates a shift from institution-centered to woman-centered care, from fragmented service to continuous care, and from single technical operation to comprehensive services integrating emotional support, information communication, and decision-making participation.

At present, the International Confederation of Midwives actively advocates the midwife-led continuity of care model. It refers to personalized woman-centered care provided by the same midwife or midwifery team throughout pregnancy, childbirth, and the postpartum period [11]. This model originated from the *Changing Childbirth* issued by the United Kingdom in 1993 [12], which aimed to achieve the goal of assigning one experienced midwife to every pregnant woman to provide continuous care throughout the process of childbirth within 5 years. This document emphasized the participation, selection, and control of pregnant and puerperal women during the antenatal, intrapartum, and postpartum periods. According to this viewpoint, Western countries began exploring midwife-led continuity of care models. In 2016, the *Better Births* proposal in the United Kingdom suggested that safe care should be provided on the basis of mutual trust and women's decisions should be respected [13]. It recommended that every woman should have a midwife from a small community-based team composed of 4–8 midwives who is familiar with the woman and her family, and able to provide midwife-led continuity of care throughout pregnancy, childbirth, and the postpartum period. This midwifery concept has been extensively applied in multiple countries internationally (e.g., Australia, Sweden, and the United States), especially the caseload midwifery model adopted in Australia. By funding caseload midwifery training programs, the Australian government has incorporated this model into the woman-centered national public health system to support the continuity of the midwifery care model continuously [14–18].

With the renewal of the midwifery concept, domestic research and exploration on the midwife-led continuity of care model have been carried out successively in China [19–23]. It is believed that this model adheres to the woman-centered service concept and implements personalized nursing services for pregnant and puerperal women during pregnancy, childbirth, and the postpartum period. It may contribute to reducing the incidence of complications following vaginal delivery, alleviating labor pain, improving maternal childbirth experience and satisfaction, as well as guaranteeing obstetric safety and quality. However, it may still be challenging to promote the practice of midwife-led continuity of care model in China. First, in terms of the connotation of continuity, intrapartum continuity and partial antenatal continuity (e.g., midwifery clinics) are major concerns in the current domestic practice, while the postpartum stage is mostly managed by ward nurses, triggering a discontinuity of care from the delivery room to the obstetric ward. There remains a gap between this fragmented continuity and the international concept of continuous care covering the whole cycle of pregnancy, childbirth, and motherhood. Second, there are relatively insufficient domestic studies on systematically evaluating nursing quality and safety. Most studies focused primarily on single outcomes, such as pain score or satisfaction survey, with the lack of a systematic and multi-dimensional comprehensive evaluation of

nursing quality and safety. In response to the above, this study was conducted to further explore the impact of the midwife-led continuity of care model on the quality and safety of nursing in the delivery room. With a controlled design, this study systematically evaluated the effects of a midwife-led continuity of care model on delivery complications, pain management, satisfaction, and safety indicators.

Subjects and Methods

General Data

In this study, the experimental group consisted of singleton pregnant and puerperal women (18–40 years) who completed routine prenatal examinations, chose vaginal delivery, and volunteered to participate in the study at *Yangming Hospital Affiliated to Ningbo University (Yuyao People's Hospital)* between April 2024 and March 2025. The control group incorporated pregnant and puerperal women within the same age range who completed routine prenatal examinations and underwent vaginal delivery at our hospital from April 2022 to March 2023. This study was designed as a quasi-experimental study with a historical control group, with official approval by the Ethics Committee of our hospital (Approval No.: 2024-06-006). Meanwhile, estimation of the sample size was conducted considering the difference in the incidence of postpartum hemorrhage in the pre-experiment, followed by sample size calculation under the criteria of $\alpha = 0.05$ and $(1-\beta) = 0.80$. Finally, 1,000 cases were included in the experimental group and 2,139 cases in the control group, meeting the requirements of statistical analysis.

Inclusion and Exclusion Criteria

Inclusion Criteria

☑ Pregnant and puerperal women who completed routine prenatal examinations in our hospital from April 2024 to March 2025 and had indications for vaginal trial of labor; ☑ Pregnant and puerperal women with singleton cephalic pregnancies aged 18–40 years who chose vaginal delivery and voluntarily accepted midwife-led continuity of care.

Exclusion Criteria

☑ Women who converted to cesarean section during labor; ☑ Women who could not cooperate with the study due to mental illness, cognitive impairment, or other conditions during pregnancy.

Methods

Parturients in the control group given routine intrapartum nursing care, such as antenatal health education, labor guidance during delivery, routine 2-hour postpartum monitoring, and early neonatal health care. The 1,000 eligible pregnant and puerperal women in the experimental group were provided with the midwife-led continuity of care model. The details are as follows:

Establishment of the Midwife-led Continuity of Care Team

For providing such care model, a midwife-led continuity of care team composed of 15 professionals was established, including 1 obstetrician, 1 pediatrician, 1 head nurse, 2 junior midwives, and 10 senior midwives. To be specific, the obstetrician was responsible for addressing maternal-related issues during the intervention, while the pediatrician took charge of infant-related concerns. The head nurse was responsible for plan adjustment and staff coordination in the process. Junior midwives (with at least 5 years of working experience) were responsible for participant recruitment; while senior midwives (with at least 10 years of working experience) implemented specific care during the antenatal, intrapartum, and postpartum periods, guided pregnant and puerperal women to participate in relevant knowledge training, and strengthened communication with these participants and their families.

Formulation of Working Rules for the Midwife-led Continuity of Care Team

Antenatal Management

☒ Antenatal assessment: A midwifery clinic was constructed to conduct preliminary assessment on the general health status, past medical history, and prenatal examination results of the current pregnancy for the pregnant women, establish antenatal files, and invite pregnant women to join the WeChat group of the department. ☒ Antenatal education: Antenatal education was realized through online knowledge dissemination via WeChat groups and official accounts, combined with offline practical training. ☒ Antenatal intervention: A. Perineal massage would be provided for pregnant women after 35 weeks of gestation in the midwifery clinic according to perineal conditions; B. In the third trimester, pregnant women were familiarized with the delivery room and participated in childbirth scenario simulations to contribute to their relief of mental stress and alleviation of anxiety; C. Team members established rapport with pregnant women and maintained timely communication to improve the cooperation of pregnant women and their families.

Intrapartum Management

☒ Family accompaniment: At least one member of the midwife-led continuity of care team was present during labor. Family members were allowed to accompany the woman in the labor room. Pregnant women could opt for doula accompaniment, and one-to-one personalized guidance would be provided by a dedicated midwife throughout the delivery process with the accompaniment of family members, thereby accelerating the labor process, reducing the maternal demand for analgesia, and the probability of operative delivery, and decreasing maternal dissatisfaction with the childbirth experience. ☒ Pain management: Available methods for labor analgesia included epidural analgesia and non-pharmacological analgesic techniques (e.g., massage and hot compress, transcutaneous electrical nerve stimulation, aromatherapy, or audio analgesia). ☒ Specialized nursing: The perineal condition would be assessed by the midwives during delivery, with the implementation of perineal massage according to

the perineal condition; women were allowed to adopt free birth positions during the second stage of labor, and the optimal timing of delivery would be assessed by the senior midwives to provide appropriate perineal protection to lower the risk of perineal trauma, with the completion of file documentation as well.

Postpartum Management

☒ Enhanced follow-up: Based on postpartum follow-up in the ward during hospitalization, parturients were subjected to at least one home visit or telephone follow-up after discharge by the midwives to understand maternal recovery as well as neonatal growth and development. Meanwhile, communication with parturients would be strengthened to promptly alleviate their negative emotions. ☒ Breastfeeding guidance: In-ward visits were provided by breastfeeding consultants from the breastfeeding clinic within 24 hours to conduct individual assessment and guide parturients on breastfeeding. ☒ Discharge instructions: A "green channel" was established for readmitted parturients on the basis of routine handover with community-based health care after discharge. Systematic maternal and infant health re-examination was completed at 42 days postpartum, with file documentation. ☒ Continuous care: At the same time of introducing home-based nursing instructions including postpartum perineal wound care and breastfeeding, the process of placing orders on the "Zheli Nursing" platform was explained and demonstrated to parturients and their families. If necessary, orders could be placed online in advance, and midwives would provide specialized nursing care at home offline.

Observation Indicators

Both groups were subjected to the collection of baseline data, vaginal delivery outcomes, and incidence of common complications following vaginal delivery (e.g., neonatal asphyxia, postpartum hemorrhage, shoulder dystocia, cervical laceration, vaginal wall hematoma, third/fourth-degree perineal laceration), labor pain status, doula accompaniment rate, neuraxial labor analgesia rate, maternal satisfaction with childbirth, incidence of adverse events and complaints.

Statistical Analysis

All data were entered and processed using SPSS 27.0. Measurement data conforming to a normal distribution were presented in the form of mean $\pm$ standard deviation ($\bar{x} \pm s$), and inter-group comparison was performed by *t*-test. Meanwhile, non-normally distributed measurement data were expressed as median (interquartile range) [M (P25, P75)]. Counting data were described as number of cases (*n*), constituent ratio (%) or rate (%). A value of *P* < 0.05 was considered statistically significant. To control for potential confounding factors such as age, gestational age, gravidity, and parity, multivariate logistic regression analysis, in addition to univariate analysis, was performed on relevant factors that might affect delivery outcomes and the occurrence of complications. Additionally, in order to reduce the impact

of temporal bias, the two groups were consistent in inclusion criteria, management process and statistical methods.

Results

Inter-group Comparison of Baseline Characteristics of Parturients

As shown in Table 1, there were no statistically significant differences in maternal age, body mass index (BMI), gestational age, neonatal weight, and parity between groups ($P > 0.05$), indicating the existence of comparability between groups.

Table 1
Inter-group Comparison of Baseline Characteristics of Parturients.

Variable	Subgroup	Experimental group (n = 1,000)	Control group (n = 2,139)	Z/ χ^2	P
Age (years)	-	28.00 (26.00, 31.00)	28.00 (26.00, 31.00)	-1.461	0.144
BMI (kg/m ²)	-	26.56 (24.45, 28.99)	26.56 (24.49, 28.76)	-0.606	0.544
Gestational age (weeks)	-	39.50 (38.86, 40.14)	39.43 (38.71, 40.14)	-1.562	0.118
Neonatal weight (g)	-	3300.00 (3050.00, 3550.00)	3300.00 (3050.00, 3550.00)	-0.747	0.455
Parity	Primiparous	577 (57.70)	1218 (56.94)	0.160	0.689
	Multiparous	423 (42.30)	921 (43.06)	-	-

Inter-group Comparison of Delivery Outcomes and Common Complications following Vaginal Delivery

There was a statistically significant difference in the mode of delivery between groups ($\chi^2=4.035$, $P = 0.045$). Compared with 92.2% and 7.8% in the control group, the spontaneous vaginal delivery rate was 90.1% and the operative vaginal delivery rate was 9.9% in the experimental group. However, there was minimal actual difference in the mode of delivery between groups, given an effect size (Cramer's V) of only 0.036. Furthermore, there were no statistically significant differences in neonatal asphyxia, shoulder dystocia, vaginal wall hematoma, and third/fourth-degree perineal laceration between groups (all $P > 0.05$). The incidence of postpartum hemorrhage (3.7% vs. 9.2%) and cervical laceration (6.4% vs. 12.1%) in the experimental group was significantly lower than that in the control group, indicating significant inter-group differences ($\chi^2=29.596$, and $\chi^2=24.055$, both $P < 0.001$). The effect sizes (Cramer's V) of the two indicators were 0.097 and 0.088, respectively, suggesting a clear effect of this intervention on reducing the risk of postpartum hemorrhage and cervical laceration. Nevertheless, no significant effect was observed on other delivery complications and delivery outcomes. The specific results are detailed in Table 2.

Table 2

Inter-group Comparison of Delivery Outcomes and Common Complications following Vaginal Delivery.

Variable	Experimental group (n = 1,000)	Control group (n = 2,139)	χ^2	<i>P</i>
Mode of delivery	-	-	4.035	0.045
Spontaneous vaginal delivery	901 (90.1)	1973 (92.2)	-	-
Operative vaginal delivery	99 (9.9)	166 (7.8)	-	-
Neonatal asphyxia	-	-	—	0.449
Yes	1 (0.1)	7 (0.3)	-	-
No	999 (99.9)	2132 (99.7)	-	-
Complications	-	-	-	-
Postpartum hemorrhage	37 (3.7)	196 (9.2)	29.596	< 0.001
Shoulder dystocia	2 (0.2)	10 (0.5)	—	0.359
Cervical laceration	64 (6.4)	259 (12.1)	24.055	< 0.001
Vaginal wall hematoma	1 (0.1)	7 (0.3)	—	0.449
Third/fourth-degree perineal laceration	0 (0.0)	4 (0.2)	—	0.314
Note: The effect sizes (Cramer's V) for the delivery mode, postpartum hemorrhage, shoulder dystocia, cervical laceration, vaginal wall hematoma, and third/fourth-degree perineal laceration were 0.036 ($P = 0.045$), 0.097 ($P < 0.001$), 0.020 ($P = 0.258$), 0.088 ($P < 0.001$), 0.021 ($P = 0.239$), and 0.024 ($P = 0.171$), respectively.				

Inter-group Comparison of Labor Pain Interventions and Effects

As revealed in Table 3.1, there were extremely significant statistical differences in doula accompaniment, neuraxial labor analgesia, as well as the excellent and good rate of labor pain relief between groups (all $P < 0.001$). Inter-group comparisons indicated significantly higher doula accompaniment rate (84.3% vs. 39.4%), neuraxial labor analgesia rate (80.0% vs. 74.5%), and excellent and good rate of labor pain relief (80.5% vs. 74.5%) in the experimental group than those in the control group. The effect size (Cramer's V) of doula accompaniment reached 0.420, indicating a strong association and a substantial difference in this core intervention between groups. Meanwhile, there were weak-to-moderate effect sizes of neuraxial labor analgesia (0.060) and labor pain relief (0.102), indicating a significant impact of the intervention on maternal analgesic options and pain perception.

The ineffective rate of labor pain relief in the experimental group was higher than that in the control group (3.4% vs. 1.5%). With the independent variables determined as grouping, age, BMI, parity, neonatal weight, doula accompaniment, neuraxial labor analgesia, duration of each stage of labor, etc., this study

continued to carry out a logistic regression analysis. Prior to the construction of the binary logistic regression model, a multicollinearity test was performed on 10 potential independent variables. Consequently, the variance inflation factor (VIF) values of the duration of the first and second stages of labor, as well as the total duration of labor were far higher than 10, indicating severe multicollinearity among these labor-related variables, potentially leading to unstable regression coefficients and interpretation bias. The VIF values of other variables were all less than 2, and the tolerance was > 0.5 , revealing no significant collinearity (Table 3.2). Furthermore, with the use of the stepwise method, four significant predictors were screened out, including the total duration of labor, neuraxial labor analgesia, parity, and grouping. The overall goodness of fit was good [likelihood ratio test: $\chi^2=235.69$ ($df = 4$, $P < 0.001$); and Nagelkerke $R^2=0.380$], as shown in Table 3.3. Among these, the total duration of labor had a negative predictive effect (OR = 0.998, 95% CI: 0.997-1.000, $P = 0.014$), suggesting that each 1-minute prolongation of labor duration would reduce the risk of ineffective pain relief by approximately 0.17%. Parity (multiparous vs. primiparous) significantly reduced the risk of ineffectiveness (OR = 0.223, 95% CI: 0.127–0.392, $P < 0.001$), and the probability of ineffectiveness in multiparous women was only 22.3% of that in primiparous women. Moreover, the grouping was identified to be a protective factor (OR = 0.343, 95% CI: 0.204–0.576, $P < 0.001$), and the risk of ineffectiveness was reduced by 65.7% in the experimental group compared with the control group, verifying the protective effect of the experimental intervention independently. Critically, the most prominent risk factor was neuraxial labor analgesia (OR = 420.25, 95% CI: 56.16-3144.62, $P < 0.001$), and the use of pharmacological analgesia increased the risk of ineffectiveness by 420 times.

Table 3.1
Inter-group Comparison of Labor Pain Interventions and Effects.

Variable	Experimental group (n = 1,000)	Control group (n = 2,139)	χ^2	P
Doula accompaniment	-	-	553.379	< 0.001
Yes	843 (84.3)	842 (39.4)	-	-
No	157 (15.7)	1297 (60.6)	-	-
Neuraxial labor analgesia	-	-	11.302	< 0.001
Yes	800 (80.0)	1594 (74.5)	-	-
No	200 (20.0)	545 (25.5)	-	-
Labor pain relief	-	-	32.966	< 0.001
Excellent and good rate	805 (80.5)	1590 (74.5)	-	-
Fair rate	161 (16.1)	514 (24.0)	-	-
Ineffective rate	34 (3.4)	35 (1.5)	-	-

Table 3.2
Results of Multicollinearity Analysis of Variables.

Item	VIF value	Tolerance
Group	1.228	0.814
Age	1.136	0.880
BMI	1.079	0.927
Parity	1.825	0.548
Doula accompaniment	1.348	0.742
Neonatal weight	1.101	0.908
Neuraxial labor analgesia	1.377	0.726
First stage of labor (min)	2391.501	0.000
Second stage of labor (min)	97.964	0.010
Total labor duration	2821.626	0.000

Table 3.3
Logistic Regression Results of Factors Associated with Ineffective Labor Pain Relief.

Item	Regression coefficient	Standard error	z value	Wald χ^2	P value	OR value	95% CI for OR
Total labor duration	-0.002*	0.001	-2.469	6.094	0.014	0.998	0.997 ~ 1.000
Neuraxial labor analgesia	6.041**	1.027	5.883	34.608	< 0.001	420.251	56.163 ~ 3144.624
Parity	-1.502**	0.288	-5.206	27.107	< 0.001	0.223	0.127 ~ 0.392
Group	-1.070**	0.265	-4.041	16.327	< 0.001	0.343	0.204 ~ 0.576
Constant	-9.403**	2.112	-4.452	19.818	< 0.001	0.000	0.000 ~ 0.005

Inter-group Comparison of Maternal Childbirth Satisfaction, Complaints, and Adverse Events

As summarized in Table 4, the rate of maternal satisfaction with childbirth was higher in the experimental group than that in the control group (99.1% vs. 98.2%), with a statistically significant difference ($\chi^2=14.651$, $P = 0.003$). The complaint rate was 0.1% and 0.3% in the experimental group and the control group, respectively, with no significant difference ($P = 0.442$). The incidence of adverse events was 0.1% in both groups, with no statistically significant inter-group difference ($P = 0.536$). Collectively, the intervention exhibited good safety, which would improve maternal childbirth experience, without increasing the incidence of complaints and adverse events.

Table 4
Inter-group Comparison of Maternal Childbirth Satisfaction, Complaints, and Adverse Events

Variable	Experimental group (n = 1,000)	Control group (n = 2,139)	χ^2	P
Maternal childbirth satisfaction	991 (99.1)	2101 (98.2)	14.651	0.003
Very satisfied	935 (93.5)	1913 (89.4)	-	-
Satisfied	56 (5.6)	188 (8.7)	-	-
Fair	4 (0.4)	10 (0.5)	-	-
Dissatisfied	5 (0.5)	26 (1.2)	-	-
Very dissatisfied	0 (0.0)	2 (0.1)	-	-
Complaints	-	-	—	0.442
Yes	1 (0.1)	6 (0.3)	-	-
No	999 (99.9)	2133 (99.7)	-	-
Adverse events	-	-	—	0.536
Yes	1 (0.1)	1 (0.1)	-	-
No	999 (99.9)	2138 (99.9)	-	-

Regression Analysis of Related Variables of Delivery Outcomes

Logistic regression analysis was performed on 7 variables involving delivery outcome and postpartum hemorrhage (Table 5). As a result, postpartum hemorrhage (OR = 0.421, 95%CI: 0.286 ~ 0.621, $P < 0.001$), cervical laceration (OR = 0.429, 95%CI: 0.315 ~ 0.584, $P < 0.001$), doula accompaniment (OR = 9.557, 95%CI: 7.777 ~ 11.745, $P < 0.001$), pain score (OR = 0.586, 95%CI: 0.358 ~ 0.958, $P = 0.033$), maternal satisfaction with childbirth (OR = 0.667, 95%CI: 0.524 ~ 0.849, $P = 0.001$) and constant ($P < 0.001$) were statistically significant factors affecting adverse delivery outcomes. Among these, doula accompaniment was a strong protective factor, and maternal satisfaction with childbirth was a protective factor; while postpartum hemorrhage, cervical laceration, and pain score were risk factors. Additionally, no statistical significance was observed in delivery outcome ($P = 0.204$) and neuraxial labor analgesia ($P = 0.572$), indicating that these two variables had no significant effect on adverse delivery outcomes.

Table 5
Logistic Regression Results of Related Variables of Delivery Outcomes

Variable	B	Standard error	Wald	Significance	OR	95%CI Lower limit	95%CI Upper limit
Delivery outcome	-0.192	0.151	1.616	0.204	0.826	0.614	1.109
Postpartum hemorrhage	-0.864	0.198	19.07	< 0.001	0.421	0.286	0.621
Cervical laceration	-0.847	0.157	29.042	< 0.001	0.429	0.315	0.584
Doula accompaniment	2.257	0.105	460.6	< 0.001	9.557	7.777	11.745
Neuraxial labor analgesia	0.166	0.294	0.319	0.572	1.180	0.664	2.099
Pain score	-0.535	0.251	4.543	0.033	0.586	0.358	0.958
Maternal childbirth satisfaction	-0.405	0.123	10.8	0.001	0.667	0.524	0.849
Constant	3.637	0.811	20.091	< 0.001	37.969	-	-

Discussion

This comparative analysis demonstrated that the midwife-led continuity of care model had differential effects across multiple dimensions. First, the experimental group had a higher operative vaginal delivery rate, while significantly lower incidence of postpartum hemorrhage and cervical laceration than those in the control group, yet without significant differences in other complications following vaginal delivery. Second, the experimental group experienced superior pain relief through delivery interventions (doula accompaniment and neuraxial labor analgesia). Finally, the experimental group also had a remarkably higher overall rate of maternal satisfaction with childbirth. These multifaceted findings reveal the distinct mechanistic pathways through which the midwife-led continuity of care model exerts its physiological and psychological supportive effects. This study may provide a critical foundation for comprehensive understanding of the clinical value of this model.

Comparison of Operative Vaginal Delivery Rate

In this study, the application of midwife-led continuity of care resulted in a higher operative vaginal delivery rate than that of routine intrapartum nursing care (9.9% vs 7.8%), which was consistent with those reported by several studies internationally. However, a meta-analysis by Sandall et al. including 17 studies and 18,533 women indicated that midwife-led continuity of care models might reduce the incidence of instrumental (forceps/vacuum) deliveries compared with conventional care models [24]. We

conducted an in-depth analysis of this discrepancy, and the underlying reasons are as follows: First, the increased operative vaginal delivery rate may be attributed objectively to the widespread use of labor analgesia. As indicated in our study, the experimental group undergoing midwife-led continuity of care had significantly higher rates of doula accompaniment and neuraxial labor analgesia, with better pain relief. Critically, the only adverse obstetric effect of epidural analgesia is the prolongation of the second stage of labor, as stated by the *Oxford Advanced Anesthesia Review (2023)*. A domestic study by Zhu et al. found that prolonged second stage of labor might increase the risk of operative vaginal delivery [25]. Therefore, the higher operative delivery rate in the experimental group may represent the potential prolongation of labor associated with effective analgesia, rather than an inherent drawback of the midwife-led continuity of care model itself. Second, the midwife-led continuity of care model with full-time midwife accompaniment may facilitate more detailed observation of labor progress, and the increased forceps delivery rate may reflect that this delivery method replaces part of cesarean sections. Finally, given the inclusion of a slightly more primiparous women (57.70% vs 56.94%) than that in the control group, the experimental group might inadvertently include more primiparous women with potential high-risk factors, leading to baseline bias.

Comparison of Postpartum Hemorrhage and Cervical Laceration

Basically consistent with domestic and international studies, midwife-led continuity of care could effectively reduce the incidence of postpartum hemorrhage and cervical laceration. A study by Rekiku et al. also confirmed the effect of midwife-led continuity of care models on significantly reducing the risk of postpartum hemorrhage [26]. A domestic meta-analysis by Lu et al. (2022) corroborated and further verified the unique value of midwife-led continuity of care in reducing postpartum hemorrhage and cervical laceration [27]. Mechanistically, the antenatal midwifery clinic can identify high-risk factors in advance, which can benefit the implementation of active prevention during labor, thereby effectively lowering the occurrence of postpartum hemorrhage. Second, the nationwide promotion of labor analgesia in China advocates the standardized development of non-pharmacological analgesic services (e.g., professional accompanied delivery) and round-the-clock neuraxial labor analgesia delivery services, leading to an effective alleviation of labor pain, prevention of premature use of abdominal pressure, and reduction of the occurrence of cervical laceration [28, 29]. Finally, during delivery, guidance from senior midwives and family accompaniment can alleviate parturients' fear caused by labor pain and an unfamiliar environment; midwives and family members can stabilize parturients' emotions and make them cooperate more actively. As reported previously, midwives could guide parturients in the Lamaze breathing technique and effective Valsalva pushing during the second stage of labor, encourage them to timely supplement water and energy, and ensure that they had sufficient physical strength to complete vaginal delivery, thus reducing the risk of postpartum hemorrhage [30, 31].

Comparison of Labor Pain Interventions and Effects

In this study, via interventions such as doula accompaniment and neuraxial labor analgesia, parturients with midwife-led continuity of care achieved better pain relief than the control group, highly consistent

with many domestic and international studies. However, this group was observed with paradoxically higher ineffective rate of labor pain relief than that in the control group, a finding that diverges from some previous reports. Logistic regression analysis was performed for this discrepancy. The experimental group was found to have a 65.7% lower risk of ineffectiveness compared with the control group, which independently verified the protective effect of the proposed intervention. Nevertheless, the most prominent risk factor was neuraxial labor analgesia (OR = 420.25, 95%CI: 56.16-3144.62, $P < 0.001$), with pharmacological analgesia associated with a 420-fold increase in the risk of ineffective pain control. Paradoxically, it contradicts the well-established clinical consensus that neuraxial analgesia effectively can relieve labor pain, which can be explained by the following reasons. First, channeling bias (confounding by indication), that is, a systematic assignment of parturients with higher pain intensity or dystocia risk to receive neuraxial labor analgesia, led to the presence of a "treatment paradox" in observational studies [32]. Second, neuraxial labor analgesia has a technical failure rate. As evidenced by a systematic review involving 21 studies (44,790 participants) by Zegeye et al., the failure rate of neuraxial anesthesia was 8.36% (95% CI: 6.94–9.78) [33]. In contrast, doula accompaniment, as a non-pharmacological intervention, exhibited a universal protective effect in the overall sample (OR = 0.525). This discovery was consistent with domestic and international reports, confirming its core value in obstetric practice from multiple dimensions.

Maternal Childbirth Satisfaction in Continuity of Midwifery Care Model

Additionally, parturients receiving midwife-led continuity of care reported significantly higher overall maternal satisfaction with childbirth compared to the control group, which was highly consistent with that concluded by domestic and international studies. Internationally, the COSMOS randomized controlled trial conducted by Forster et al. in 2016 found that midwife-led continuity of care can improve maternal satisfaction during the antenatal, intrapartum, and postpartum periods [34]. Consistent conclusions were also reached in domestic studies, especially for high-risk parturients with a history of cesarean section, whose satisfaction was significantly higher than that of the control group [20]. In terms of the underlying mechanism, the midwife-mother relationship can be established initially through antenatal approaches such as antenatal schools and midwifery clinics [36, 37]; this relationship will be gradually deepened via childbirth scenario simulation before delivery [38, 39]; doula accompaniment during labor can further consolidate and stabilize this relationship; and postpartum continuity of care can subsequently enhance this relationship [40–44]. Altogether, personalized care is delivered, trust is built, and maternal autonomy is respected throughout the whole process, thereby comprehensively improving the experience of delivery.

Limitations

Indeed, this study highlights the positive significance of the midwife-led continuity of care model. Several limitations still exist in this study. First, given a single-center experimental design, this study was conducted based on a relatively concentrated sample source, which might affect the generalizability of the results. Second, this study adopted a non-concurrent control design, which might introduce changes

in the medical environment or management strategies in different time periods, resulting in a risk of temporal bias to a certain extent. Third, delivery may be affected by multiple factors; although no statistically significant inter-group differences were observed in the baseline data, and the influence of potential confounding factors cannot be completely eliminated. In addition, the evaluation of maternal satisfaction with childbirth in this study did not adopt a standardized scale, highlighting further optimization of the objectivity and reproducibility of the measurement tool. Finally, the implementation of the midwife-led continuity of care model also imposed an all-round challenge for midwives, and the cultivation of professional midwives was the determinant [45–47].

Conclusion

In summary, the midwife-led continuity of care model extends midwifery services forward to the antenatal period and backward through the intrapartum period to the postpartum follow-up phase. Based on full play to the professional autonomy of midwives, this interventional modality can effectively reduce the incidence of postpartum hemorrhage and cervical laceration during vaginal delivery, improve maternal labor pain relief and satisfaction with childbirth, which is pivotal in ensuring parturients' quality and safety within the delivery room, as well as promoting maternal and infant health. However, the widespread promotion of this model requires more high-quality clinical studies and the systematic cultivation of specialized midwifery workforce to promote the sustainable development of the midwife-led continuity of care model.

Declarations

Ethical approval and consent to participate

Human Ethics and Consent to Participate declarations: This study was approved by the Ethics Committee of Ningbo University Affiliated Yangming Hospital (Approval No. 2024-06-006], Date: [06/07/2024]). All participants provided written informed consent prior to enrollment. The study was conducted in accordance with the Declaration of Helsinki. All personal information was anonymized to protect patient privacy.

Consent for publication

Not Applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article. The raw data are available from the corresponding author upon reasonable request with ethical permission.

Author Contributions

Wenming Lu: Experimental design, manuscript writing;

Sumengdie Li: Data analysis, figure preparation;

Yanwei Yu: Experimental design, manuscript revision, research supervision;

Hongling Xie: Data collection, organization, and analysis;

Sangsang Huang, Chunbo Mao: Conducted experiments and collected data.

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Competing interests

The authors declare that they have no competing interests.

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