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Research Article

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Maternal and perinatal outcomes of ART-conceived versus naturally conceived twins: a propensity score-matched retrospective cohort study

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Maternal and perinatal outcomes of ART-conceived versus naturally conceived twins: a propensity score-matched retrospective cohort study

Abstract

Background This study aimed to estimate the independent impact of assisted reproductive technology (ART) on maternal and perinatal outcomes in twin pregnancies after adjusting for major baseline confounding factors.

Methods This retrospective cohort study analyzed 917 twin pregnancies (515 ARTs, 402 natural conceptions) at a tertiary hospital in China (2019–2023). Propensity score matching (PSM) (1:1 nearest-neighbor matching, caliper=0.05) was used to balance the baseline characteristics. The outcomes included maternal complications (gestational diabetes [GDM], postpartum hemorrhage [PPH], etc.) and neonatal parameters (birth weight, preterm birth, NICU admission, etc.).

Results Pre-PSM, the ART mothers were older (31.73 ± 3.68 vs. 29.81 ± 3.86 years, P < 0.001) and had higher BMIs (22.20 ± 3.11 vs. 21.24 ± 2.88 kg/m², P < 0.001) and GDM incidences (30.10% vs. 22.64%, P = 0.011) and greater PPH volumes (438.35 ± 212.02 vs. 384.28 ± 157.54 mL, P < 0.001). Neonatal birth weights were greater for ART twins (first twin: 2444.54 ± 439.85 vs. 2311.05 ± 404.65 g, P < 0.001; second twin: 2372.53 ± 427.53 vs. 2242.66 ± 450.71 g, P < 0.001). Post-PSM (196 pairs), ART remained associated with increased PPH volume (435.97 ± 214.96 vs. 382.55 ± 166.93 mL, P = 0.006) and birth weight (first twin: 2469.31 ± 403.07 vs. 2365.09 ± 405.95 g, P = 0.011; second twin:2382.83 ± 416.37 vs. 2296.07 ± 438.36 g, P = 0.045). Initial

disparities in GDM, preterm birth, and NICU admission resolved after matching (P > 0.05).

Conclusion In twin pregnancies, ART is independently associated with increased postpartum blood loss and higher neonatal birth weight but not with other maternal complications or adverse neonatal outcomes after accounting for baseline confounders. These findings suggest that increased surveillance for PPH is warranted in ART-conceived twins, whereas a higher birth weight may confer a neonatal advantage.

Keywords: Twins, Assisted reproductive technology, Natural conception, Propensity score matching, Pregnancy outcomes

1. Introduction

Infertility remains a major global reproductive health challenge, affecting an estimated 10.1 million women globally as of 2021[1]. The birth of the first baby through in vitro fertilization (IVF) in 1978 marked a milestone [2]. Subsequently, assisted reproductive technology (ART) completely revolutionized infertility treatment[3]. According to the report of the International Committee on the Monitoring of Assisted Reproductive Technology (ICMART) in 2014, a total of 1,929,905 ART cycles were conducted across 76 countries, resulting in more than 439,039 live births [4]. Moreover, the fourth report of the African Network and Registry for ART showed that 37,063 ART procedures were carried out across 67 centers in 15 countries in 2020, with more than 20% of these procedures resulting in multiple deliveries [5]. As stated in the Clinical Practice Bulletin of the American College of Obstetricians and Gynecologists, widespread ART use has

significantly increased the incidence of multiple pregnancies, particularly twin pregnancies[6]. Marleen et al. conducted a systematic review including 111 studies with 802,462 pregnancies and reported that, compared with twins conceived naturally, twins conceived through ART presented increased risks of maternal gestational diabetes mellitus (GDM), pregnancy-induced hypertension (PIH), and cesarean delivery, as well as neonatal prematurity, respiratory distress syndrome (RDS), and admissions to the neonatal intensive care unit (NICU) [7]. However, some studies have yielded contradictory conclusions, suggesting that ART itself may not directly cause adverse pregnancy outcomes[8, 9]. It is noteworthy that numerous earlier relevant studies failed to adequately adjust for confounding variables, including maternal age, comorbidities, and chorionicity. To minimize the influence of these confounding factors, our study employed the propensity score matching (PSM) method to conduct a retrospective cohort analysis aimed at investigating the net effect of ART on twin pregnancy outcomes.

2. Research methods

2.1 Ethics statement

The Ethics Committee at the Maternal and Child Health Hospital of Hubei Province (affiliated with Tongji Medical College, Huazhong University of Science and Technology) reviewed and approved this study (Approval No. 2025-051-01). Informed consent requirements were waived by the IRB because of the retrospective design.

2.2 Research design and population

This retrospective cohort study analyzed twin pregnancies at the Maternal and Child

Health Hospital of Hubei Province, a tertiary referral center with an annual delivery volume reaching 29,000, from March 1, 2019, to March 1, 2023.

2.3 Enrollment and disqualification criteria

The inclusion criteria were as follows: dichorionic diamniotic (DCDA) or monochorionic diamniotic (MCDA) twins with a gestational age ≥28 weeks who conceived spontaneously or via ART (IVF/intracytoplasmic sperm injection [ICSI]).

Disqualification criteria: Monochorionic monoamniotic twins, intrauterine fetal death, twin pregnancies reduced from triplets or higher-order gestations, missing data, and pregnancies conceived via ovulation induction/intrauterine insemination (IUI) without manipulation of gametes.

2.4 Data collection and study variables

All the collected cases were stratified by conception method into two groups: natural versus ART. The maternal variables included age, gravidity, parity, prepregnancy body mass index (BMI), pregnancy-associated complications, gestational age, delivery method and postpartum hemorrhage volume. The neonatal data included the Apgar score, birth weight, congenital abnormality, incidence of RDS and NICU admission.

Pregnancy-induced hypertension (PIH) is established when hypertension (⩾ 140/90 mmHg twice at least 4 h apart) first appears at ≥20 weeks of gestation, regardless of proteinuria (urinary protein excretion ≥300 mg/24 h) or other end-organ dysfunction [10].

Gestational diabetes mellitus (GDM) is established through a 75 g OGTT conducted at 24–28 gestational weeks, with cutoff values of fasting ≥5.1,1-h ≥10.0, or

112 2-h ≥8.5 mmol/L [11].

113 Placenta previa is diagnosed when the lower edge of the placenta lies either
114 directly over the internal cervical os or within 20 mm of it [12].

115 Placental abruption is diagnosed when the placenta partially or completely
116 separates from the uterine wall before the fetus is delivered[13].

117 Premature rupture of membranes (PROM) is diagnosed when the amniotic
118 membranes break spontaneously before the onset of labor [14].

119 Preterm prefetal membrane rupture (PPROM) is diagnosed when the amniotic
120 membranes break spontaneously before 37 gestational weeks without the onset of labor
121 [15].

122 Preterm birth is defined as delivery occurring before 37 gestational weeks [16].

123 Intrahepatic cholestasis of pregnancy (ICP) is defined as pruritus occurring in the
124 third trimester of pregnancy, accompanied by TBA levels exceeding 10 μmol/L and
125 abnormal liver biochemistry [17].

126 Low birth weight (LBW) refers to a newborn weighing less than 2500 grams at
127 delivery.

128 Very low birth weight (VLBW) refers to the birth weight of a newborn being less
129 than 1500 grams.

130 Respiratory distress syndrome (RDS) is defined as a neonate with typical imaging
131 findings and symptoms of shortness of breath, nasal burning, purring, intercostal or
132 subcostal retraction, and cyanosis requiring 24-hour oxygen administration[18].

133 **2.5 Statistical analyses**

We employed R software (version 4.4.0) and the Zstats package (version 1.0; official website: www.zstats.net) to perform propensity score matching (PSM), utilizing a 1:1 nearest neighbor matching method with a caliper width of 0.05. This procedure balanced baseline characteristics, including maternal age, gravidity, parity, BMI, chronic hypertension, pregestational diabetes mellitus, history of cesarean section, and chorionicity. Successful matching was confirmed when all covariates had standardized mean differences (SMDs) ≤ 0.1. Continuous variables are expressed as the mean ± standard deviation (SD) if normally distributed, whereas the median (interquartile range) was used for non-normal distributions. Categorical variables are presented as counts and percentages. Group comparisons were performed via Student's t tests, Mann–Whitney U tests, or χ^2 tests, as appropriate. A two-tailed P value <0.05 was considered statistically significant.

3. Results

3.1 Baseline data comparison

The natural conception group included 402 twin pregnancies, whereas the ART group consisted of 515 pregnancies (shown in Figure 1). Before PSM, the two groups were significantly different ($P < 0.05$) with respect to maternal age, BMI, gravidity, parity, chorionicity, and previous cesarean section. Specifically, ART mothers were significantly older (31.73 ± 3.68 vs. 29.81 ± 3.86 years, $P < 0.001$) and had a higher BMI (22.20 ± 3.11 vs. 21.24 ± 2.88 kg/m², $P < 0.001$) than those in the natural conception group did, whereas lower gravidity, parity and cesarean delivery rates

characterized the ART group (detailed in Table 1). After PSM (196 pairs), the baseline characteristics were balanced ($P > 0.05$, SMD < 0.1; refer to Table 2).

3.2 Perinatal outcomes comparison

Prior to PSM, the ART cohort presented elevated rates of hypothyroidism ($P = 0.002$) and GDM ($P = 0.011$) and increased postpartum hemorrhage volume ($P < 0.001$) relative to the natural conception cohort. No statistically significant differences were observed in other obstetric complications (all $P > 0.05$). Neonatal outcomes in the ART group demonstrated clinically favorable trends, including prolonged mean gestational duration ($P = 0.040$), increased neonatal birth weight ($P < 0.001$), higher rates of full-term deliveries ($P = 0.016$), a reduced incidence of very low birth weight (VLBW) in second twins ($P = 0.003$) and NICU admission ($P = 0.006$). No significant intergroup differences were observed in the remaining neonatal parameters (all $P > 0.05$; see Table 3). After PSM adjustment, the degree of postpartum blood loss in the ART group remained significantly greater ($P = 0.006$), whereas the characteristics of obstetric complications in both groups tended to be balanced (all $P > 0.05$). Interestingly, ART-conceived twins presented higher birth weights for both the first ($P = 0.011$) and second twins ($P = 0.045$), whereas other newborn outcomes did not differ after matching (all $P > 0.05$; see Table 4).

4. Discussion

There is little dispute that ART represents a landmark advance in reproductive medicine. However, this progress has come with a trade-off: the persistence of multiple embryo transfer strategies has maintained multiple gestation rates that are substantially higher

than those in naturally conceived pregnancies. Multifetal pregnancies are recognized risk factors for adverse perinatal outcomes, such as spontaneous abortion, preterm delivery, and fetal growth restriction [19]. However, whether ART itself has an independent effect on pregnancy outcomes remains unknown.

Many previous observational studies comparing pregnancy outcomes between ART and natural conception have been limited by substantial confounding factors, which may be attributed to the fact that patients undergoing ART are typically older and carry a greater burden of metabolic and reproductive system comorbidities [20-22]. Our PSM methodology has reduced interference from confounding factors by balancing eight main variables, such as maternal age, body mass index, parity status and chorionicity characteristics. With this approach, we were able to separate the “treatment effect” of ART from the “patient effect” of underlying infertility. Our analysis clearly revealed significant differences in maternal and neonatal outcomes between ART-conceived twin pregnancies and naturally conceived pregnancies. The most notable independent associations were a marked increase in PPH volume and higher neonatal birth weight in the ART group. Importantly, after adjustment for maternal baseline characteristics, initial disparities in GDM, hypothyroidism, and preterm birth rates disappeared. The results strongly suggest that certain negative outcomes previously blamed on ART are mediated primarily by the underlying characteristics of the subfertile population rather than by ART itself.

In our study, the PPH volume in the ART group was significantly greater than that in the natural conception group, which is consistent with observations from a large-

scale retrospective cohort study [23]. This association persisted after PSM, suggesting a possible iatrogenic effect. There are several plausible biological mechanisms worth considering. First, ART increases the incidence of placental abnormalities such as placenta previa and accreta spectrum disorders [24], both of which are known as the main contributors to PPH [25]. Second, the hormonal environment induced by controlled ovarian stimulation may reduce endometrial receptivity and impair trophoblastic invasion, resulting in abnormal implantation and diminished postpartum uterine contractility. Additionally, ART recipients often have coexisting uterine pathologies such as fibroids, adenomyosis, or endometriosis, all of which have been established as independent contributors to uterine atony and PPH [26].

Our study found that ART-conceived twins had higher neonatal birth weight than naturally conceived counterparts, which remained robust even after adjusting for confounding variables; while this finding overturned the conventional view that ART increases the risk of adverse neonatal outcomes [8, 27, 28]. This encouraging research finding may partially reduce prematurity-related risks, and several mechanisms may account for this phenomenon. First, the healthy embryo selection hypothesis warrants consideration. This hypothesis posits that embryos transplanted into recipients are likely to exhibit greater developmental potential for surviving the rigorous in vitro culture conditions and the subsequent transplantation procedure [25]. Second, women undergoing ART are often from higher socioeconomic backgrounds and receive rigorous prenatal monitoring [29, 30]; consequently, they often exhibit better nutritional status and receive timely intervention for complications such as selective intrauterine

growth restriction (sIUGR), contributing to improved fetal weight-related outcomes. By contrast, the natural conception group includes many unplanned pregnancies, which often involve lower adherence to prenatal care and may confound the intergroup comparisons.

Our study found that the ART group had a significantly greater prevalence of GDM than that in the naturally conceived group (30.10% vs. 22.64%), aligning with earlier report [22]. Similarly, the incidence of hypothyroidism was higher in the ART group, which further corroborates earlier cross-sectional findings that women undergoing ART may have autoimmune dysregulation [31]. Notably, after PSM, the intergroup differences in both GDM and hypothyroidism prevalence lost statistical significance, indicating that the pre-adjustment elevated risks were primarily driven by maternal baseline characteristics rather than by ART-related procedures. Both higher BMI and advanced maternal age are well-recognized independent risk factors for GDM and thyroid dysfunction, and these characteristics are more prevalent among ART patients [32]. This insight holds significant clinical value for prenatal counseling, as it allows clinicians to shift preventive strategies toward preconception maternal health.

Our findings hold direct implications for obstetric clinical practice. First, obstetricians should recognize that ART-conceived twin pregnancies carry an independently and significantly increased risk of postpartum hemorrhage. Therefore, thorough preparation is essential, including timely availability of uterotonics, careful prenatal assessment of placental position, and maintenance of high vigilance during labor or surgery. Second, ART-conceived twins exhibit higher neonatal birth weights,

which is a gratifying outcome. However, enhanced monitoring for other complications specific to twin pregnancies remains necessary. Third, our study found that several pregnancy complications are associated with underlying maternal characteristics rather than with ART itself. Therefore, clinicians should enhance preconception care, focusing on optimizing body weight and screening for metabolic and endocrine disorders among women planning ART.

By employing PSM, our study achieved sufficient statistical power and effectively controlled for confounding variables, thereby minimizing selection bias and optimizing intergroup comparability. Although the methodology is rigorous, certain limitations remain. First, the single-center, retrospective nature of our study may restrict the external validity of the findings. Second, we lacked data on placental pathology and systemic inflammation, preventing exploration of the underlying mechanisms of the observed associations. Third, our study elucidates only short-term perinatal outcomes. Whether children born from ART twin pregnancies experience adverse long-term neurodevelopmental or metabolic health issues is still unknown, and this is a crucial area for future research.

5. Conclusion

In summary, this propensity score matching analysis clarified the independent impact of ART on twin pregnancy outcomes. ART is directly associated with elevated risks of postpartum hemorrhage and higher neonatal birth weight, whereas the increased risks of GDM and hypothyroidism are driven primarily by the maternal baseline profile. Future investigations are warranted to fully clarify the biological mechanisms

underlying ART-associated outcomes and to develop targeted strategies for optimizing the health of both mothers and children in ART twin pregnancies.

Abbreviations

ART	Assisted reproductive technology
PSM	Propensity score matching
GDM	Gestational diabetes
PPH	Postpartum hemorrhage
NICU	Neonatal intensive care unit
IVF	In vitro fertilization
PIH	Pregnancy-induced hypertension
RDS	Respiratory distress syndrome
DCDA	Dichorionic diamniotic
MCDA	Monochorionic diamniotic
ICSI	Intracytoplasmic sperm injection
IUI	Intrauterine insemination
BMI	Body mass index
PROM	Premature rupture of membranes
PPROM	Preterm prefetal membrane rupture
ICP	Intrahepatic cholestasis of pregnancy
LBW	Low birth weight (LBW)
VLBW	Very low birth weight

SMD Standardized mean difference

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Authors' contributions

JC and QY conceptualized this study. JC was responsible for data curation, formal analysis, investigation, and visualization, and drafted the original manuscript. QY developed the methodology, supervised the study, handled project administration, and reviewed and edited the manuscript. All authors reviewed the manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and ethical restrictions, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Ethics Committee at the Maternal and Child Health Hospital of Hubei Province (affiliated with Tongji Medical College, Huazhong University of Science and Technology) reviewed and approved this study (Approval No. 2025-051-01).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflicts of interest.

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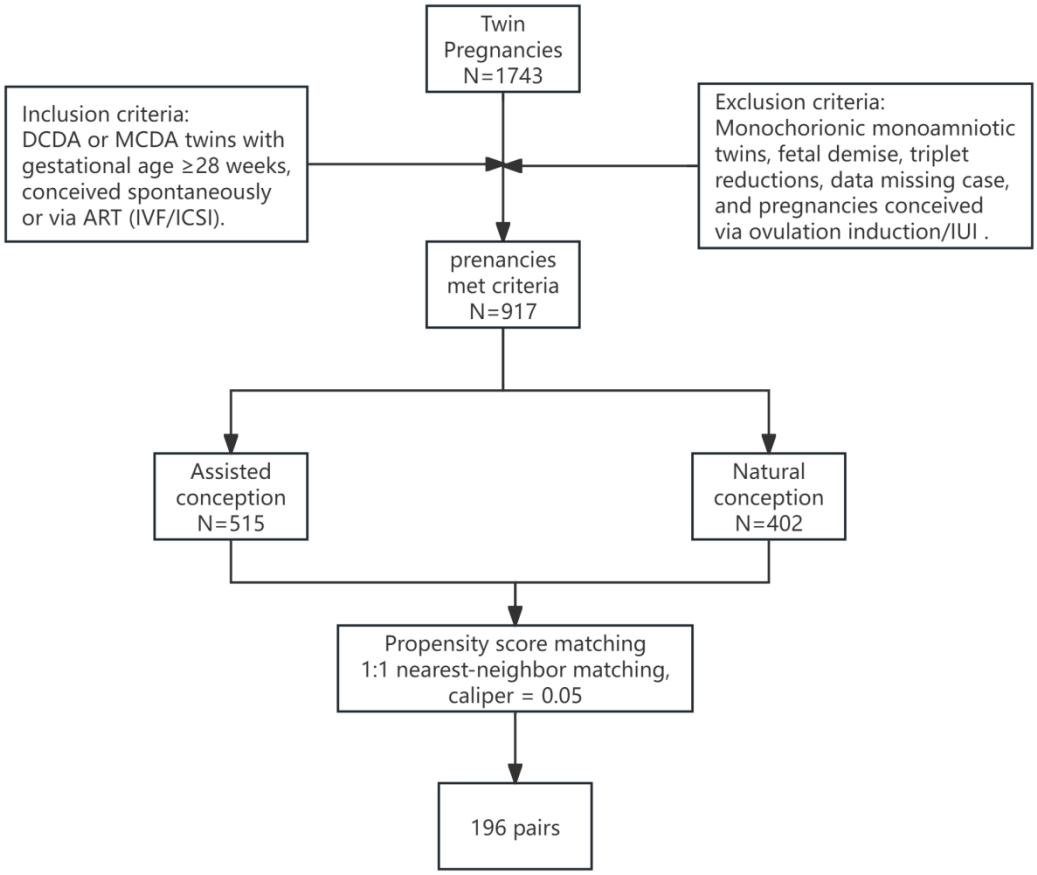


Figure 1 Flowchart of cohort.

Abbreviations: ICSI: intracytoplasmic sperm injection; IVF: in vitro fertilization; IUI: intrauterine insemination.

TABLE 1 Maternal characteristics according to the mode of conception(before PSM)

Maternal characteristics	Natural conception (n = 402)	Assisted conception (n = 515)	Statistic	P	SMD
Age, Mean ± SD	29.81 ± 3.86	31.73 ± 3.68	t=-7.680	<.001	0.522
BMI, Mean ± SD	21.24 ± 2.88	22.20 ± 3.11	t=-4.787	<.001	0.308
Gravidity, M (Q_1, Q_3)	2.00 (1.00, 3.00)	1.00(1.00, 2.00)	Z=-4.962	<.001	-0.391
Parity, M (Q_1, Q_3)	0.00 (0.00, 1.00)	0.00(0.00, 0.00)	Z=-9.220	<.001	-0.720
Chorionicity, n (%)			χ^2=222.569	<.001	
MCDA	198 (49.25)	32 (6.21)			-1.783
DCDA	204 (50.75)	483 (93.79)			1.783
Chronic hypertension, n (%)	6 (1.49)	9 (1.75)	χ^2=0.091	0.763	0.019
PGDM, n (%)	3 (0.75)	5 (0.97)	χ^2=0.000	0.996	0.023
Previous cesarean, n (%)	74 (18.41)	32 (6.21)	χ^2=32.839	<.001	0.505

Abbreviations: BMI: pre-pregnancy body mass index; MCDA: monochorionic diamniotic; DCDA:dichorionic diamniotic; PGDM: pregestational diabetes mellitus.

TABLE 2 Maternal characteristics according to the mode of conception(after PSM)

Maternal characteristics	Natural conception (n = 196)	Assisted conception (n = 196)	Statistic	P	SMD
Age, Mean ± SD	30.50 ± 3.80	30.33 ± 3.43	t=0.461	0.645	-0.049
BMI, Mean ± SD	21.92 ± 3.00	21.68 ± 2.92	t=0.808	0.420	-0.083
Gravidity, M (Q_1, Q_3)	2.00 (1.00, 2.00)	1.50 (1.00, 2.00)	Z=-0.202	0.840	-0.028
Parity, M (Q_1, Q_3)	0.00 (0.00, 1.00)	0.00 (0.00, 0.00)	Z=-1.239	0.215	-0.067
Chorionicity, n (%)			χ^2=0.299	0.585	
MCDA	34 (17.35)	30 (15.31)			-0.057
DCDA	162 (82.65)	166 (84.69)			0.057
Chronic hypertension, n (%)	3 (1.53)	2 (1.02)	χ^2=0.000	1.000	-0.051
PGDM, n (%)	1 (0.51)	2 (1.02)	χ^2=0.000	1.000	0.051
Previous cesarean, n (%)	21 (10.71)	23 (11.73)	χ^2=0.102	0.749	0.032

Abbreviations: BMI: pre-pregnancy body mass index; MCDA: monochorionic diamniotic; DCDA: dichorionic diamniotic; PGDM: pregestational diabetes mellitus.

TABLE 3 Obstetric and neonatal outcomes according to mode of conception (before PSM)

	Natural Conception (n = 402)	Assisted conception (n = 515)	Statistic	P
Obstetric outcomes				
PPH, Mean ± SD	384.28 ± 157.54	438.35 ± 212.02	t=-4.43	<.001
PIH, n(%)	75 (18.66)	108 (20.97)	χ^2=0.76	0.384
ICP, n(%)	19 (4.73)	22 (4.27)	χ^2=0.11	0.741
Hypothyroidism, n(%)	28 (6.97)	68 (13.20)	χ^2=9.38	0.002
Hyperthyroidism, n(%)	9 (2.24)	4 (0.78)	χ^2=3.45	0.063
PROM, n(%)	47 (11.69)	53 (10.29)	χ^2=0.46	0.500
PPROM, n(%)	44 (10.95)	50 (9.71)	χ^2=0.38	0.540
GDM, n(%)	91 (22.64)	155 (30.10)	χ^2=6.40	0.011
Placenta previa, n(%)	8 (1.99)	18 (3.50)	χ^2=1.86	0.173
Placental abruption, n(%)	3 (0.75)	6 (1.17)	χ^2=0.09	0.764
Delivery methods, n(%)			χ^2=1.62	0.203
vaginal delivery	9 (2.24)	6 (1.17)		
cesarean delivery	393 (97.76)	509 (98.83)		
Neonatal outcomes				
Gestational days, Mean ± SD	248.37 ± 12.37	250.07 ± 12.54	t=-2.05	0.040
BW 1, Mean ± SD	2311.05 ± 404.65	2444.54 ± 439.85	t=-4.72	<.001
BW 2, Mean ± SD	2242.66 ± 450.71	2372.53 ± 427.53	t=-4.46	<.001
Very low birth weight 1(<1500 g)	12 (2.99)	15 (2.91)	χ^2=0.00	0.949
Very low birth weight 2(<1500 g)	31 (7.71)	17 (3.30)	χ^2=8.85	0.003
Neonatal asphyxia 1, n(%)	11 (2.74)	8 (1.55)	χ^2=1.56	0.212
Neonatal asphyxia 2, n(%)	13 (3.23)	8 (1.55)	χ^2=2.85	0.091
Early preterm delivery(< 34w)	61 (15.17)	70 (13.59)	χ^2=0.46	0.497
Term delivery(⩾37 w)	76 (18.91)	132 (25.63)	χ^2=5.82	0.016
Malformation, n(%)	16 (3.98)	21 (4.08)	χ^2=0.01	0.941
NICU, n(%)	233 (57.96)	251 (48.74)	χ^2=7.70	0.006
RDS, n(%)	25 (6.22)	26 (5.05)	χ^2=0.59	0.443

Abbreviations: PPH:postpartum hemorrhage; PIH:pregnancy-induced hypertension; ICP: intrahepatic cholestasis of pregnancy; PROM: premature rupture of membranes; PPROM: preterm premature rupture of membranes; GDM: gestational diabetes mellitus; BW:birth weight; NICU, neonatal intensive care unit; RDS:respiratory distress syndrome.

TABLE 4 Obstetric and neonatal outcomes according to mode of conception (after PSM)

	Natural Conception (n = 196)	Assisted conception (n = 196)	Statistic	P
Obstetric outcomes				
PPH, Mean ± SD	382.55 ± 166.93	435.97 ± 214.96	t=-2.75	0.006
PIH, n(%)	39 (19.90)	35 (17.86)	χ^2=0.27	0.606
ICP, n(%)	11 (5.61)	7 (3.57)	χ^2=0.93	0.334
Hypothyroidism, n(%)	18 (9.18)	20 (10.20)	χ^2=0.12	0.733
Hyperthyroidism, n(%)	4 (2.04)	0 (0.00)	χ^2=2.27	0.132
PROM, n(%)	28 (14.29)	17 (8.67)	χ^2=3.04	0.081
PPROM, n(%)	27 (13.78)	15 (7.65)	χ^2=3.84	0.050
GDM, n(%)	48 (24.49)	51 (26.02)	χ^2=0.12	0.727
Placenta previa, n(%)	5 (2.55)	12 (6.12)	χ^2=3.01	0.083
Placental abruption, n(%)	3 (1.53)	1 (0.51)	χ^2=0.25	0.615
Deliverymethods, n(%)			χ^2=0.25	0.615
vaginal delivery	3 (1.53)	1 (0.51)		
cesarean delivery	193 (98.47)	195 (99.49)		
Neonatal outcomes				
Gestational days, Mean ± SD	250.36 ± 11.74	250.74 ± 11.87	t=-0.32	0.752
BW 1, Mean ± SD	2365.09 ± 405.95	2469.31 ± 403.07	t=-2.55	0.011
BW 2, Mean ± SD	2296.07 ± 438.36	2382.83 ± 416.37	t=-2.01	0.045
Very low birth weight 1(<1500 g)	5 (2.55)	5 (2.55)	χ^2=0.00	1.000
Very low birth weight 2(<1500 g)	11 (5.61)	7 (3.57)	χ^2=0.93	0.334
Neonatal asphyxia1, n(%)	4 (2.04)	3 (1.53)	χ^2=0.00	1.000
Neonatal asphyxia2, n(%)	4 (2.04)	3 (1.53)	χ^2=0.00	1.000
Early preterm delivery(< 34w)	22 (11.22)	22 (11.22)	χ^2=0.00	1.000
Term delivery(⩾37w)	48 (24.49)	56 (28.57)	χ^2=0.84	0.360
Malformation, n(%)	5 (2.55)	6 (3.06)	χ^2=0.09	0.760
NICU, n(%)	101 (51.53)	100 (51.02)	χ^2=0.01	0.920
RDS, n(%)	8 (4.08)	11 (5.61)	χ^2=0.50	0.480

Abbreviations: PPH:postpartum hemorrhage; PIH:pregnancy-induced hypertension; ICP: intrahepatic cholestasis of pregnancy; PROM: premature rupture of membranes; PPROM: preterm premature rupture of membranes; GDM: gestational diabetes mellitus; BW:birth weight; NICU, neonatal intensive care unit; RDS:respiratory distress syndrome.