The adverse maternal and perinatal outcomes of adolescent pregnancy: a cross sectional study in Hebei, China

Ting Zhang

Hebei General Hospital <https://orcid.org/0000-0003-2580-8754>

Yingkui Zhang

Hebei Women and Children's Center

Huien Wang

Hebei General Hospital

Yue Yang

Hebei General Hospital

Zengjun Tang

Hebei General Hospital

Li Wang (✉ wangli719@126.com)

Hebei General Hospital <https://orcid.org/0000-0002-2940-5461>

Research article

Keywords: Adolescent, Pregnancy, Maternal outcomes, Neonatal outcomes

Posted Date: November 14th, 2019

DOI: <https://doi.org/10.21203/rs.2.17282/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background Adolescent pregnancy was a serious problem in the world, especially in developing countries. While Chinese adolescent population were about 1/4 of the total population, but have few studies focused on adolescence pregnancy in China. Thus, we aimed to clarify pregnant adverse maternal and perinatal outcomes among adolescent women by analyzing the data of childbirth in Hebei Province, a large population province in China.

Methods We used the Hebei Provincial Maternal and Child Health Center Perinatal Database, including 238,598 singleton pregnancy women aged 10-34 between 2013 and 2017. They were divided into two groups: Adolescent group (10-19 years) and adult group (20-34 years), compared risk of adverse pregnancy outcomes using Poisson regression, Univariate and Multivariate Logistic Regression.

Results Adolescents pregnancy women had a lower risk of cesarean delivery [adjusted risk ratio (aRR): 0.75, 95% confidence interval: 0.70-0.80] and gestational diabetes mellitus (GDM) (aRR: 0.55, 95% CI: 0.41-0.73). Adolescent pregnancy had an increased risk of preterm birth (aRR: 1.76, 95% CI: 1.54-2.01), small for gestational age (SGA) (aRR: 1.19, 95% CI: 1.08-1.30), stillbirth (aRR: 2.58, 95% CI: 1.83-3.62), neonatal death (aRR: 2.63, 95% CI: 1.60-4.32). And the risk of preeclampsia, HELLP syndrome, placenta previa, placental abruption, postpartum hemorrhage were negatively associated with adolescent pregnancy. There was a lower morbidity of anemia and a higher maternal mortality in adolescent pregnancy ($P < 0.05$). However, there were no difference in the effects of anemia (aRR: 1.04, 95% CI: 0.96-1.12) and maternal mortality (aRR: 2.61, 95% CI: 0.20-33.77) after adjusting for confounding factors.

Conclusions Adolescent pregnancy was related to perinatal adverse outcomes, but was not related to maternal adverse outcomes. Adolescent pregnancy was a protective factor for caesarean section and GDM, independent risk factor for preterm birth, SGA, stillbirth and neonatal death.

Background

Adolescent pregnancy was defined as pregnancy at the age of 10–19 [1]. About 11% of newborns worldwide were delivered by adolescents, the pregnancy complications account for 23% of women of all ages, and more than 90% of them occurred in developing countries [2]. Compared with adult women, adolescent women pregnancy usually increases the risk of adverse pregnancy outcomes, including fetal growth restriction, preterm labor and neonatal death [3]. By a biological point, adolescent girls were in a transitional period to maturity, with immature physiology and psychology, insufficient knowledge of sexual and reproductive, which increased the risk of pregnancy [4, 5].

The adverse pregnancy outcomes caused by teenage pregnancy was a major public health problems with enormous social impact [6, 7]. Pregnancy complications were the major cause of death in adolescent women in developing countries [8]. Adolescent pregnancy was a serious problem in the world, especially in developing countries [2]. Although the rate of adolescents pregnancy has declined, with the increasing

of adolescents population, the number of adolescent pregnancy was large, especially in developing countries [9, 10].

Chinese adolescent population were about 1/4 of the total population, but there were few studies on adolescence pregnancy in a large population. This study analyzed the delivery data of 22 monitoring points in Maternal Near Miss Surveillance System of Hebei Province in China from 2013 to 2017, and to evaluated the adverse pregnancy outcomes in adolescent women.

Methods

This cross sectional study was performed based on Hebei province Maternal Near Miss Surveillance System (HBMNMSS), with 22 hospitals distributed in 15 cities of Hebei Province. Of 289,895 parturients who gave birth between January 2013 and December 2017. The demographic and obstetric information of mothers and babies were collected from all deliveries. Adolescent parturients (≤ 19 years) were 4125 (1.4%), adult parturients (20–34 years) were 250,522 (86.4%), advanced parturients (≥ 35 years) were 27,140 (9.4%), and parturients with missing data of age were 8108 (2.8%). we enrolled parturients aged 10–34 years, who categorized into two groups: adolescent group (≤ 19 years) and adult group (20–34 years). The adult group was considered to be the reference group.

The adverse maternal and perinatal outcomes were defined as: cesarean section, anemia, gestational diabetes mellitus (GDM), pre-eclampsia (PE), HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count syndrome), placenta previa, placental abruption, postpartum hemorrhage, preterm delivery, small for gestational age (SGA), neonatal low Apgar score, stillbirth, and neonatal death. Pre-eclampsia was defined as hypertension after 20 weeks of gestation (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg), with proteinuria (300 mg/d) or liver, kidney functional failure, or nerve, blood system abnormalities [11]; HELLP syndrome was a serious complication of pre-eclampsia, including hemolysis, elevated liver enzymes, thrombocytopenia [11]; SGA was the tenth percentile of fetal birth weight below the gestational age [12]; delivered in 28–36⁺⁶ gestational weeks were defined as preterm delivery [13]; Low Apgar score in 5 min ≤ 7 ; neonatal death included neonatal death at birth and before delivery.

The counting data were expressed as n(%), and measurement data were expressed as mean $\pm$ standard deviation (mean $\pm$ SD); Two groups compared with Poisson regression, univariate and multivariate logistic regression. The results were expressed as risk ratio (RR) or adjusted odds ratio (aOR) and 95% confidence interval. Adjusted confounding factors as: maternal educational time, marital status, place of residence, delivery place, gravidity, parity, history of cesarean section, previous hypertension. All data analyses were performed using SPSS 17.0 statistical software. $P < 0.05$ was considered statistically significant.

Results

The data of 289,985 parturient were collected from 2013 to 2017 in HBMNMSS of Hebei province, China. Exclude multiple pregnancies (n=4482), gestational weeks missing or < 28 weeks (n=14,452), Birth weight missing or < 1000g (n= 932), maternal age missing or ≥35 years (n= 31,431). Our study included Our study included 238,598 single-pregnant women with aged 10-34 years old. These pregnant women were divided into two groups, the adolescent pregnancy group (10-19 years, n=3679) and the adult pregnancy group (20-34 years, n=234,919). The case screening flow was showed in figure 1. In the adolescent group, of ≤15 years was 88 (2.4%), 16-17 years was 174 (4.7%), 18 years was 979 (26.6%), 19 years was 2010 (54.6%). (Figure 2) .

The adolescent parturient were more single status than adult (5.1% versus 0.4%) (P=0.000), and more lower education for ≤6 years (6.1% versus 1.8%) and 7-9 years (62.2% versus 34.3%) (P<0.001). The adolescent parturient had delivered in secondary hospital or home mostly than adult parturient. Number of prenatal care in the adolescent group (5.6±2.2) was less than that in the adult group (6.8±2.4) (P<0.001). Baby birth weight of adolescence were lower than adults (3204±509g versus 3344±491g) (P<0.001). (Table 1).

Table 1 The characteristics of parturients

	10-19 years (n=3679)	20-34 years (n=234,919)	F/c2	P
Marital status				
Married	3492(94.9)	234,033(99.6)		
Single	187(5.1)	886(0.4)	1791.693	0.000
Education (year)				
≤6	222(6.1)	4258(1.8)		
7-9	2265(62.2)	79,550(34.3)		
10-12	899(24.7)	70,870(30.5)		
>12	253(7.0)	77,343(33.3)	1946.923	0.000
Delivery place				
Tertiary Hospital	950(25.8)	108,383(46.1)		
Secondary Hospital	2722(74.0)	126,348(53.8)		
Primary Hospital*	0(0)	19(0.8)		
Home or Clinic *	7(19)	163(6.9)	607.250	0.000
Prenatal care	5.6(2.2)	6.8(2.4)	889.906	0.000
Parity				
0	3328(90.5)	127,414(54.3)		
1	315(8.6)	98,078(41.8)		
≥2	35(1.0)	9324(4.0)	1918.563	0.000
History of miscarriage	421(11.4)	59,531(25.4)	372.160	0.000
Chronic hypertension	15(0.4)	1352(0.6)	1.790	0.181
Gestational age (weeks)	38.9(1.9)	38.9(1.5)	0.000	0.993
Birth weight (g)	3204(509)	3344(491)	292.171	0.000

Date of pregnancy women were obtained from Hebei province Maternal Near Miss Surveillance System (HBMNMSS). The value are mean (SD) or n (%) unless stated otherwise. *Rate per 10,000 women.

Compared with adult parturient, the adolescent parturient had lower morbidity rates of cesarean section (39.1% versus adult 50.6%), anemia (24.5 versus adult 26.05), and GDM (1.3% versus adult 3.6%) ($P<0.05$). Maternal death (2.7‰ versus adult 0.3‰), Premature delivery (7.5% versus adult 5.2%), SGA (14.4% versus adult 11.7%), stillbirth (1.1% versus adult 0.3%) and neonatal (0.5% versus adult 0.2%) mortality in adolescent group were higher than those in adult group ($P<0.05$) (Table 2).

Table 2 Adverse maternal and perinatal outcomes

	10-19 years (n=3679)	20-34 years (n=234,919)	F/c2	P
	n (%)	n (%)		
Cesarean delivery	1439(39.1)	118,791(50.6)	190.063	0.000
Anemia	900(24.5)	61,050(26.0)	4.380	0.036
GDM	49(1.3)	8406(3.6)	53.477	0.000
Preeclampsia	95(2.6)	5647(2.4)	0.491	0.484
HELLP syndrome	5(0.1)	169(0.1)	2.034	0.154
Placenta previa	7(0.2)	924(0.4)	3.843	0.050
Placental abruption	11(0.3)	606(0.3)	0.236	0.627
Postpartum hemorrhage	11(0.3)	700(0.3)	0.000	0.991
Maternal death*	1(2.7)	7(0.3)	6.328	0.012
Preterm delivery	275(7.5)	12,256(5.2)	37.106	0.000
SGA	528(14.4)	27,484(11.7)	24.593	0.000
Lower Apgar at 5 min	12(0.3)	524(0.2)	1.825	0.177
Stillbirth	41(1.1)	814(0.3)	59.825	0.000
Neonatal death	18(0.5)	453(0.2)	16.447	0.000

The value are n (%) unless stated otherwise. *Rate per 10,000 women. GDM : gestational diabetes mellitus .HELLP syndrome: hemolysis, elevated liver enzymes, and low platelet count syndrome.

SGA : small for gestational age.

Risks of adverse outcomes of adolescent parturients were shown in Table 3. In maternal outcomes, compared with adult pregnancy, adolescent pregnancy had a statistically significant lower risk of cesarean section (aRR: 0.75, 95% CI: 0.70-0.80), GDM (aRR: 0.55, 95%CI: 0.41-0.73). Adolescent pregnancy was a protective factor for cesarean section and GDM. And adolescent parturients had a significant higher risk of preterm delivery (aRR: 1.76, 95%CI: 1.54-2.01), SGA (aRR: 1.19, 95%CI: 1.18-1.30), stillbirth (aRR: 2.58, 95%CI: 1.83-3.62), neonatal death (aRR: 2.60, 95%CI: 1.63-4.32). There was a lower risk of anemia (RR: 0.92, 95% CI: 0.86-0.99) in adolescent pregnancy, a higher risk of maternal death (RR: 9.12, 95% CI: 1.12-74.18), but there were no statistically significant difference in the effects of anemia (aRR: 1.04, 95%CI: 0.96-1.12) and maternal death (aRR: 2.61, 95%CI: 0.20-33.77) after adjusting for

confounding factors. There were more perinatal adverse outcomes in adolescent pregnancy ($P<0.001$), even after adjusted regression analysis. (Table 3 and Figure 3).

Table 3 Risks of adverse outcomes of adolescent parturients

	RR	95%CI	P	aRR	95%CI	P
Cesarean delivery	0.63	0.59-0.67	<0.001	0.75	0.70-0.80	<0.001
Anemia	0.92	0.86-0.99	<0.05	1.04	0.96-1.12	0.325
GDM	0.36	0.27-0.48	<0.001	0.55	0.41-0.73	<0.001
Preeclampsia	1.08	0.88-1.32	0.484	1.00	0.81-1.24	0.999
HELLP syndrome	1.89	0.78-4.60	0.161	2.26	0.89-5.72	0.086
Placenta previa	0.48	0.23-1.02	0.055	1.02	0.48-2.16	0.968
Placental abruption	1.16	0.64-2.11	0.627	1.31	0.71-2.41	0.393
Postpartum hemorrhage	1.00	0.55-1.82	0.991	1.27	0.69-2.33	0.448
Maternal death	9.12	1.12-74.18	0.039	2.61	0.20-33.77	0.464
Preterm delivery	1.47	1.30-1.66	<0.001	1.76	1.54-2.01	<0.001
SGA	1.27	1.15-1.39	<0.001	1.19	1.08-1.30	<0.001
Low apgar at 5 min	1.48	0.84-2.63	0.179	1.48	0.82-2.65	0.193
Stillbirth	3..24	2.36-4.44	<0.001	2.58	1.83-3.62	<0.001
Neonatal death	2.57	1.60-4.11	<0.001	2.63	1.60-4.32	<0.001

Adjusted by maternal educational, marital status, delivery place, history of miscarriage, parity, previous cesarean section, chronic hypertension. 20-34 years old as a reference group.

RR: risk ratio. aRR: adjusted risk ratio. GDM: gestational diabetes mellitus. HELLP syndrome: hemolysis, elevated liver enzymes, and low platelet count syndrome. SGA: small for gestational age.

Discussion

The rate of adolescent pregnancy was 1.4% in Hebei province of China in 2013–2017, lower than Ganchimeg, T. et al. [2] reported in 2010–2011 of 4.3%. The difference in the rate may be result in area, period and collection system, that we collected 289,859 pregnant women in Hebei Province for 5 years, Hebei Province is a region with a developed economy in the eastern China. Ganchimeg T. et al. collected 314,623 pregnant women from 29 countries for 2–4 months, but the sample size from China was smaller than us. Ganchimeg T. et al. [2] collected data from tertiary hospitals, and our data was collected from all kinds of hospitals (including tertiary hospitals, primary hospitals, private clinic and home). Therefore, our research was representative of the adolescent pregnancy in eastern China.

In this study, we found that the adolescent pregnant women had a lower level of education, lesser number of prenatal care, more unmarried status than adult women, as Suzuki, S. [14] had found. The adolescent women choose to give birth at a lower level hospital, even at home. Most adolescent women were considered to be from rural areas, live with low income, dropout from school earlier, with poorly health education, sex education and perinatal education. Some of them was the left-behind youth that their parents away from home to work, lacking of support and help from relatives, or living in unmarried cohabitation, that adolescence women had fewer medical resources and were afraid of being discriminated against [15–17].

Compared with the adult pregnancy, the risk of cesarean section in adolescent pregnancy was reduced by 25%, consistent with the previously reported [2, 18]. Adolescent girls were in physical growth stage, with immature reproductive system, and the incidence of cephalopelvic disproportion in adolescent pregnancy was higher than in adults [19]. The rate of cesarean section was lower than adult pregnancy. First, 19-year-old adolescent women account for more than half of all adolescent pregnant women, their physical development was basically mature [20]. Second, the pelvic cavity of adolescent women was smaller than that of adult women, and the fetal weight was relatively low [21]. More preterm labor and low fetal weight, which was conducive to vaginal delivery [2, 22]. Most adolescent pregnant were from economically backward areas with limited medical conditions, and less social factors on cesarean section indication.

Consistent with previous literature reported, we found a reduced risk of GDM in adolescent pregnancy compared with adults [23]. Adolescent pregnancy was a protective factor for the onset of GDM. GDM was associated with obesity in pregnant women, and obesity usually increased with maternal age, so the risk of GDM in younger mothers was lower [3].

We had found that the risk of stillbirth and neonatal death in adolescence was 2.58 times and 2.63 times higher than that in adults. Our studies have confirmed an increased risk of premature birth, SGA, stillbirth and neonatal mortality in adolescent pregnancy compared with adults, which was consistent with some studies [2, 18, 24–26]. Adolescent girls were in their developmental stage, the uterus was immature, the blood supply to the placenta was affected by the competition between mother and fetus. Preterm birth and SGA were associated with maternal malnutrition [27], and preterm labor was positively associated with the risk of perinatal death [28]. Appropriate prenatal care could reduce the incidence of preterm labor and stillbirth [29]. With less prenatal care, insufficient nutrition during pregnancy, fetus were affected at intrauterine growth and development. And less antenatal care during pregnancy in adolescence, less preventive intervention on time [16]. However, Althabe, F. et al. [30] found that African-American adolescents had lower preterm labor rates than adults, which may be due to ethnic differences, and studies found that adolescent pregnancy did not increase the risk of SGA, and neonatal mortality [9, 30].

The adolescent pregnancy adverse maternal outcomes in our study had no difference from adult parturients, such as in PE, HELLP syndrome, placenta previa, placental abruption, postpartum hemorrhage. Some studies suggested that adolescent pregnancy increased the risk of postpartum hemorrhage and PE [16, 24]. But there were some studies consistent with our findings that there was no association with postpartum hemorrhage and preeclampsia [30–32].

Even the prevalence of anemia in adolescent pregnancy was higher than that in the adult pregnancy, but after adjusting for confounding factors, adolescent pregnancy was not a risk factor for anemia during pregnancy (aRR: 1.04, 95% CI: 0.96–1.12, $P = 0.325$), the result was consistent with the literature [26]. Previous report has found that adolescent pregnancy was a risk factor for increased maternal mortality [24, 33]. We found that maternal mortality in adolescent pregnancy was higher than in adult females, and Maternal death in adolescent pregnancy is 9 times that of maternal mortality in adult women. However adolescent pregnancy was not a risk factor for maternal mortality after adjusting for

confounding factors. The increase in maternal mortality during adolescent pregnancy was related to the social factors of maternal poverty and education [33].

The data sources was reliable in this study. We used Hebei province Maternal Near Miss Surveillance System with government-funded, the parturient covered 15 cities in Hebei Province, with large sample size and representative population. The data was not only from tertiary hospitals, but also from secondary and primary hospitals, individual clinics, and even delivered at home, which could reflect the adolescent pregnancy in Hebei Province. There were some limitations of this study. The data was absent on residence and economic status in HBMNMSS of pregnant women, or on other confounding factors that may lead to adverse pregnancy outcomes.

In conclusion, adolescent pregnancy was not related to maternal adverse outcomes compared to adult pregnancy. In contrast, adolescent pregnancy was a protective factor for caesarean section and GDM. However, adolescent pregnancy has a major impact on the adverse perinatal outcomes. Adolescent pregnancy was an independent risk factor for preterm delivery, SGA, stillbirth and neonatal death. Adolescence was not the best period for pregnancy. Health education and health care should be strengthened to improve the outcomes of adolescent pregnancy.

Abbreviations

GDM: gestational diabetes mellitus; SGA: small for gestational age; HELLP syndrome: hemolysis, elevated liver enzymes, and low platelet count syndrome; HBMNMSS: Hebei province Maternal Near Miss Surveillance System.

Declarations

Acknowledgements

We thank Hebei Women and Children's Health Center, China. As well as all participating hospitals for the provision of the data used.

Funding

Li Wang was supported by Science and Technology Department of Hebei Province, China (18397779D).

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Zhang T designed the study and wrote the initial manuscript. Zhang YK and Wang HE collected the data. Zhang T and Yang Y analyzed the data. Tang ZJ gave critical comments to the study design, interpretation. Wang L oversaw the process and gave critical comments to the study design, interpretation and revised the draft. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The protocol for this secondary analysis study was approved by the Institutional Review Board of Hebei General Hospital, China.

Consent for publication

Not applicable.

Competing interests

All authors declare that they have no competing interests.

Authors' information

¹Department of Obstetrics and Gynecology, Hebei General Hospital, No. 348 Heping Road, Shijiazhuang, Hebei, China, 050051. ²Graduate school, Hebei north university, No. 11 Diamond South Road, Zhangjiakou, Hebei, China, 075000. ³Hebei Women and Children's Health Center, No. 147 Jianhua Street, Shijiazhuang, China. ⁴Department of Thoracic Surgery, Hebei General Hospital, No. 348 Heping Road, Shijiazhuang, Hebei, China, 050051.

References

1. Kawakita T, Wilson K, Grantz KL, et al. Adverse Maternal and Neonatal Outcomes in Adolescent Pregnancy. *Journal of pediatric and adolescent gynecology*. 2016;29(2):130–136.
2. Ganchimeg T, Ota E, Morisaki N, et al. Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. *BJOG: an international journal of*

- obstetrics and gynaecology. 2014;121 Suppl 1:40–48.
3. Fleming N, Ng N, Osborne C, et al. Adolescent pregnancy outcomes in the province of Ontario: a cohort study. *Journal of obstetrics and gynaecology Canada: JOGC = Journal d'obstetrique et gynecologie du Canada: JOGC*. 2013;35(3):234–245.
 4. Amjad S, MacDonald I, Chambers T, et al. Social determinants of health and adverse maternal and birth outcomes in adolescent pregnancies: A systematic review and meta-analysis. *Paediatric and perinatal epidemiology*. 2019;33(1):88–99.
 5. Westenberg L, van der Klis KA, Chan A, et al. Aboriginal teenage pregnancies compared with non-Aboriginal in South Australia 1995–1999. *The Australian & New Zealand journal of obstetrics & gynaecology*. 2002;42(2):187–192.
 6. Kassa GM, Arowojolu AO, Odukogbe AA, et al. Prevalence and determinants of adolescent pregnancy in Africa: a systematic review and Meta-analysis. *Reproductive health*. 2018;15(1):195.
 7. Montgomery TM, Folken L, Seitz MA. Addressing adolescent pregnancy with legislation. *Nursing for women's health*. 2014;18(4):277–283.
 8. Patton GC, Coffey C, Sawyer SM, et al. Global patterns of mortality in young people: a systematic analysis of population health data. *Lancet (London, England)*. 2009;374(9693):881–892.
 9. Steenkamp M, Boyle J, Kildea S, et al. Perinatal outcomes among young Indigenous Australian mothers: A cross-sectional study and comparison with adult Indigenous mothers. *Birth (Berkeley, Calif)*. 2017;44(3):262–271.
 10. Cappa C, Wardlaw T, Langevin-Falcon C, et al. Progress for children: a report card on adolescents. *Lancet (London, England)*. 2012;379(9834):2323–2325.
 11. Tranquilli AL, Dekker G, Magee L, et al. The classification, diagnosis and management of the hypertensive disorders of pregnancy: A revised statement from the ISSHP. *Pregnancy hypertension*. 2014;4(2):97–104.
 12. Alexander GR, Himes JH, Kaufman RB, et al. A United States national reference for fetal growth. *Obstetrics and gynecology*. 1996;87(2):163–168.
 13. Vogel JP, Chawanpaiboon S, Moller AB, et al. The global epidemiology of preterm birth. *Best practice & research Clinical obstetrics & gynaecology*. 2018;52:3–12.
 14. Suzuki S. Clinical significance of pregnancy in adolescence in Japan. *The journal of maternal-fetal & neonatal medicine: the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet*. 2019;32(11):1864–1868.
 15. Nguyen PH, Sanghvi T, Tran LM, et al. The nutrition and health risks faced by pregnant adolescents: Insights from a cross-sectional study in Bangladesh. *PloS one*. 2017;12(6):e0178878.
 16. Fouelifack FY, Tameh TY, Mbong EN, et al. Outcome of deliveries among adolescent girls at the Yaounde central hospital. *BMC pregnancy and childbirth*. 2014;14:102.

17. Agbor VN, Mbanga CM, Njim T. Adolescent deliveries in rural Cameroon: an 8-year trend, prevalence and adverse maternofetal outcomes. *Reproductive health*. 2017;14(1):122.
18. Marvin-Dowle K, Kilner K, Burley VJ, et al. Impact of adolescent age on maternal and neonatal outcomes in the Born in Bradford cohort. *BMJ open*. 2018;8(3):e016258.
19. Ganchimeg T, Mori R, Ota E, et al. Maternal and perinatal outcomes among nulliparous adolescents in low- and middle-income countries: a multi-country study. *BJOG: an international journal of obstetrics and gynaecology*. 2013;120(13):1622–1630; discussion 1630.
20. Kramer KL, Lancaster JB. Teen motherhood in cross-cultural perspective. *Annals of human biology*. 2010;37(5):613–628.
21. Alves JG, Siqueira LC, Melo LM, et al. Smaller pelvic size in pregnant adolescents contributes to lower birth weight. *International journal of adolescent medicine and health*. 2013;25(2):139–142.
22. Weng YH, Yang CY, Chiu YW. Risk Assessment of Adverse Birth Outcomes in Relation to Maternal Age. *PloS one*. 2014;9(12):e114843.
23. Wang C, Wang XY, Yang HX. [Effect of maternal age on pregnancy outcomes in Beijing]. *Zhonghua fu chan ke za zhi*. 2017;52(8):514–520.
24. Leftwich HK, Alves MV. Adolescent Pregnancy. *Pediatric clinics of North America*. 2017;64(2):381–388.
25. Kassa GM, Arowojolu AO, Odukogbe AA, et al. Adverse neonatal outcomes of adolescent pregnancy in Northwest Ethiopia. *PloS one*. 2019;14(6):e0218259.
26. Mombo-Ngoma G, Mackanga JR, Gonzalez R, et al. Young adolescent girls are at high risk for adverse pregnancy outcomes in sub-Saharan Africa: an observational multicountry study. *BMJ open*. 2016;6(6):e011783.
27. Goldenberg RL, Culhane JF, Iams JD, et al. Epidemiology and causes of preterm birth. *Lancet* (London, England). 2008;371(9606):75–84.
28. Conde-Agudelo A, Belizan JM, Lammers C. Maternal-perinatal morbidity and mortality associated with adolescent pregnancy in Latin America: Cross-sectional study. *American journal of obstetrics and gynecology*. 2005;192(2):342–349.
29. Zile I, Ebela I, Rumba-Rozenfelde I. Maternal Risk Factors for Stillbirth: A Registry-Based Study. *Medicina* (Kaunas, Lithuania). 2019;55(7).
30. Althabe F, Moore JL, Gibbons L, et al. Adverse maternal and perinatal outcomes in adolescent pregnancies: The Global Network's Maternal Newborn Health Registry study. *Reproductive health*. 2015;12 Suppl 2:S8.
31. Socolov DG, Iorga M, Carauleanu A, et al. Pregnancy during Adolescence and Associated Risks: An 8-Year Hospital-Based Cohort Study (2007–2014) in Romania, the Country with the Highest Rate of Teenage Pregnancy in Europe. *BioMed research international*. 2017;2017:9205016.
32. Minjares-Granillo RO, Reza-Lopez SA, Caballero-Valdez S, et al. Maternal and Perinatal Outcomes Among Adolescents and Mature Women: A Hospital-Based Study in the North of Mexico. *Journal of*

pediatric and adolescent gynecology. 2016;29(3):304–311.

33. Verguet S, Nandi A, Filippi V, et al. Maternal-related deaths and impoverishment among adolescent girls in India and Niger: findings from a modelling study. *BMJ open*. 2016;6(9):e011586.

Figures

Figure 1

Flowchart for selection adolescent pregnant women and comparison group, 2013-2017, Hebei, China. Data of pregnancy women were obtained from Hebei province Maternal Near Miss Surveillance System (HBMNMSS).

Figure 2

Rate of adolescent pregnancy ages In the adolescent pregnancy women, of ≤ 15 years was 88 (2.4%), 16-17 years was 174 (4.7%), 18 years was 979 (26.6%), 19 years was 2010 (54.6%).

Figure 3

Risks of adverse outcomes of adolescent parturients aRR: adjusted risk ratio. GDM: gestational diabetes mellitus. HELLP syndrome: hemolysis, elevated liver enzymes, and low platelet count syndrome. SGA: small for gestational age .