Original Research

Relationship of maternal factors and obstetric complications with term singleton vs term twin neonatal outcomes: A retrospective study in China

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Abstract

Background

Neonatal birth weight and length are important indicators of neonatal survival and morbidity during later life and are influenced by maternal factors and obstetrical complications. Therefore, we aimed to determine the relationship of maternal factors and obstetric complications with term singleton vs term twin neonatal outcomes in Wuhan University Renmin Hospital, Hubei, China.

Methods

A total of 10517 neonatal births were recorded in a tertiary-hospital-based retrospective study and term singleton (n=7787) and term twins (n=169) were included for data analysis. Birth weight and birth length were measured immediately after birth. Correlation, independent student t-test, and backward multiple linear regression were used for statistical analysis.

Results

Women with singleton gestation have an increased rate of obstetric complications compared to women with twin gestation. However, a higher frequency of cesarean section and breech were found in twin gestation compared to singleton gestation. Weight before pregnancy, gestational weight gain, and gestational diabetes mellitus were significantly positive ($p<0.05$) associated with singleton neonatal birth length and weight. In contrast, preeclampsia, placenta previa, oligohydramnios, premature rupture of membrane, breech, and multiparity had a significantly negative ($p<0.05$) association with singleton neonatal birth length and weight. Maternal age was significantly positive ($p<0.05$) associated with only singleton neonatal birth weight. Moreover, the nuchal cord was significantly positive ($p<0.05$) associated with singleton neonatal birth length. On the other hand, maternal age and multiparity were significantly positive ($p<0.05$) associated with twins' neonatal birth length and weight. Furthermore, gestational weight gain was significantly positive ($p<0.05$) associated with only twins' neonatal birth weight.

Conclusion

In term gestation, obstetric complications were significantly associated with singleton birth size rather than twin birth size.

Keywords: Birth Weight; Birth Length, Maternal Factors; Obstetric Complications; Singleton, Twins.

Introduction

Neonatal birth size is normally determined by measuring neonatal birth length, weight, and head circumference immediately after birth. Either neonatal birth weight or length at birth determines the expression of growth in utero because of maternal, placental, and fetal factors[1]. Neonatal birth weight and length are important indicators of neonatal survival and morbidity during later life[2]. Neonatal birth weight and length are influenced by many factors such as obstetrical complications and maternal factors. Therefore, the identification of factors that influence neonatal birth weight and length are of special interest to perinatologists, gynecologists, and public health researchers[3].

Hypertensive disorders in pregnancy, especially preeclampsia, are one of the potential causes of maternal and infant mortality and morbidity in the world[4]. The prevalence of preeclampsia has been reported as 2-8% of all pregnancies in various countries of the world, even among different ethnic groups living in the same country[5]. Over the past five decades, many basic, clinical, and epidemiological studies have been conducted to understand the etiology and pathogenesis of pre-eclampsia but remain elusive[6]. Regarding the pathogenesis of preeclampsia, a current hypothesis is the "ischemic model." It is hypothesized that decreased uteroplacental perfusion is the basic step and the point of convergence of diverse pathogenic processes in the development of preeclampsia[7]. Intuitively, reduction in placental blood flow should induce decreased fetal growth, with an increased risk of low birth weight and intrauterine growth restriction. However, epidemiologists have not been established an association between preeclampsia and poor neonatal birth weight and length[8]. Placenta previa is one of the abnormal forms of placentation where the placentas lie below the uterine cavity, covering completely or partly the inner cervical ostium and ultimately preventing the normal vaginal birth[9]. Therefore, it is one of the major causes of maternal and neonatal mortality and morbidity[10]. The prevalence of placenta previa is about 0.5% in pregnancies[11].

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Amniotic fluid surrounds the developing fetus, which plays an important role in fetal development[12]. Within the last decade, several ultrasound methods have been used to determine amniotic fluid volume[13]. Commonly the amniotic fluid index (AFI) is measured by the four-quadrant ultrasonic technique which was further added to antepartum testing to identify fetuses at higher risk of poor perinatal outcome[14]. Oligohydramnios is referred to when the amniotic fluid index is less than 5 cm[13]. Oligohydramnios is associated with a higher risk of low birth weight[15] and intrauterine growth restriction (IUGR)[16]. Approximately, 3-5% of pregnancies involve oligohydramnios[17]. Gestational diabetes mellitus (GDM) is essential in utero determination of birth weight[18]. In GDM, failure of β-cell compensatory mechanisms and insulin resistance elevates maternal blood glucose and lipid level. These elevated substrates are transported via the placenta, overexposing the developing fetus to nutrients, and causing an increase in fetal growth[19]. The incidence of GDM is about 5% in pregnancies[20]. Premature rupture of membrane (PROM) is defined as the fracture of fetal membranes before the onset of labor, causing spontaneous leakage of amniotic fluid. PROM that occurs after 37 weeks of gestation is referred to as "term PROM". The premature rupture of membrane is associated with significant maternal and fetal morbidity and mortality. The occurrence of PROM is about 5%-10% of all pregnancies, of which almost 80% occur in term gestation[21]. A breech birth is defined as when a baby is born bottom instead of head first. Approximately, 3-5% of breech birth occurs in pregnant women at term gestation[22]. Several previous studies have investigated that neonates who are born in breech presentation most often have a lower birth weight compared to neonates born in cephalic presentation[23].

It is well known that fetal growth is influenced by maternal factors, especially maternal age[24], pre-pregnancy weight, and gestational weight gain[25]. According to previous literature, advancing maternal age is significantly associated with an increase in mean neonatal birth weight. In addition, other evidence suggests that neonatal birthweight increases from adolescence until 30 years of age, then declines. However, many researchers have found no obvious trend between maternal age and neonatal birth weight[26]. Many studies have documented the association of pre-pregnancy weight and gestational weight gain with neonatal birth weight and length[25]. It is well known that neonatal birth weight and length are positively correlated with maternal pre-pregnancy weight and gestational weight gain[27].

The present study aimed to determine the association between maternal factors and obstetric complications with term singleton vs term twin gestation.

Methods

Study population

A hospital-based retrospective study was conducted in the Wuhan University Renmin Hospital, Department of Obstetrics and Gynecology, Hubei, China from April 2013 to March 2017. All the data was collected and documented in the obstetrics register by trained nurses during individual check-ups in the gynecology and obstetrics department. A total of 7956 neonatal births were included and were further divided into singleton (n=7787) and twins (n=169) birth as shown in Fig 1. The study protocol was approved by the Ethical Review Board of Renmin Hospital. All the documented information was only used for research purposes.

Neonatal birth outcomes

The parameters recorded immediately after neonatal birth include birth weight in grams using an electronic infant scale, birth length in centimeters using a standard measuring board for neonatal. The appearance, pulse, grimace, activity, and respiration (APGAR) score was recorded at 1 minute, and at 5 minutes after birth. APGAR score was determined by evaluating the newborn baby on five simple criteria on a scale from zero to two, then summing up the five values obtained.

Maternal factors

Maternal factors such as maternal age, weight before pregnancy (WBP), weight during pregnancy, gestational weight gain (GWG), multigravidity, and multiparity were taken. Weight before pregnancy was taken on the first prenatal visit. Weight during pregnancy was taken just before delivery. The gestational weight gain was calculated by subtraction of pre-pregnancy weight and weight before delivery.

Obstetric complications

Obstetric complications were C-section, preeclampsia, placenta previa, oligohydramnios, GDM, diabetes, PROM, breech, and nuchal cord were documented.

Inclusion and exclusion criteria

Maternal inclusion criteria were primipara, multipara, singleton, and twin pregnancies. Neonatal inclusion criteria were only full-term (>37 weeks) live singleton and twin neonates. We excluded maternal and neonatal incomplete records, perinatal mortality, preterm neonates from the analysis of data.

Statistical analysis

The data were analyzed by using SPSS (Statistical Package for Social Sciences) for window version 22 (IBM Corporation, Chicago, USA). Descriptive statistics such as frequencies and percentages were calculated and presented in tables. Correlation, independent student t-test, and backward multiple linear regression analysis were conducted for data analysis. P-value (<0.05) was taken significant.

Results

Characteristics of singleton neonates and maternal obstetric complications

The singleton population consisted of a total of 7787 neonates. Of these neonates, 54% were male and 46% were female. About 98.6 % neonates were normal (>7), 1.3% intermediate (4-6), and 0.1% had low (0-3) APGAR score. Most of the neonates (61%) were born by cesarean section, while 39% were born by vaginal route. The most common maternal obstetric complication was scar uterus (15%) followed by PROM (8.9%), nuchal cord (6%), GDM (5.1%), oligohydramnios (3.3%), placenta previa (3.1%), and preeclampsia (2.9%) (Table 1).

Characteristics of twin neonates and maternal obstetric complications

The twin population consisted of a total of 169 neonates. Among these neonates, 46% were male and 54% were female. The 99.4% of neonates were normal (>7) and (0.6%) had intermediate (4-6) APGAR score. The majority of the neonates (97%) were born by cesarean section and 3% were born by vaginal route.

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Table 1: Maternal and neonatal characteristics

Maternal-neonatal characteristics		Singleton (n= 7787) N (%)	Twins (n= 169) N (%)
Multigravidity*		3778 (48.5)	67 (39.6)
Multiparity*		2202 (28.3)	23 (13.6)
Preeclampsia*		225 (2.9)	1 (0.6)
Placenta previa*		239 (3.1)	2 (1.2)
Oligohydramnios*		259 (3.3)	1 (0.6)
GDM*		401 (5.1)	7 (4.1)
Diabetes*		36 (0.5)	1 (0.6)
PROM*		696 (8.9)	8 (4.7)
Scar uterus*		1169 (15)	11 (6.5)
Breech*		225 (2.9)	6 (3.6)
Nuchal cord*		464 (6)	1 (0.6)
Mode of delivery	C-section	4728 (60.7)	163 (96.4)
	Vaginal	3059 (39.3)	6 (3.6)
Neonatal sex	Male	4191 (53.8)	78 (46.2)
	Female	3596 (46.2)	91 (53.8)
APGAR score	≥7	7681 (98.6)	168 (99.4)
	4-6	96 (1.3)	1 (0.6)
	0-3	10 (0.1)	0 (0)

Note: *= Frequency and percentage of variables with only 'Yes' value presented**,** GDM (gestational diabetes mellitus), PROM (premature rupture of membrane).

Table 2: Correlation between maternal factors and singletons neonatal birth length and weight

Maternal factors	Birth length		Birth weight	
	r	p –value	r	p- value
Maternal age	-0.005	0.6	0.04	0.0001
WBP	0.14	0.0001	0.19	0.0001
GWG	0.18	0.0001	0.22	0.0001

Note: WBP (Weight before pregnancy), gestational weight gain (GWG).

Table 3: Correlation between maternal factors and twins neonatal birth length and weight

Maternal factors	Birth length		Birth weight	
	r	p –value	r	p- value
Maternal age	0.18	0.01	0.29	0.0001
WBP	0.24	0.002	0.20	0.008
GWG	0.11	0.1	0.25	0.001

Note: WBP (Weight before pregnancy), gestational weight gain (GWG).

Table 4: Obstetric complications and singletons neonatal birth length and weight

Obstetric complications	Birth length Mean±SD		p-value	Birth weight Mean±SD		p-value
	Yes	No		Yes	No	
Preeclampsia	46.63±3.9	49.3±2.2	0.0001	2702.5±788.2	3243.6±527.4	0.0001
Placenta Previa	48±2.7	49.2±2.3	0.0001	2888.4±594	3238.7±539.1	0.0001

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Table 4 Cont...

Oligohydramnios	48.5±2.4	49.2±2.3	0.0001	3032.4±542.8	3234.7±543	0.0001
Polyhydramnios	49.3±3.4	49.2±2.3	0.8	3325.3±667.4	3227.6±543.7	0.3
GDM	49.5±2.1	49.2±2.3	0.002	3401.3±516.7	3218.6±544.1	0.0001
Diabetes	49.9±1.9	49.2±2.3	0.07	3558.6±688.6	3226.4±543	0.0001
PROM	48.6±2.8	49.3±2.3	0.0001	3053.9±612	3245.1±534.1	0.0001
Scar uterus	49.09±2.2	49.26±2.3	0.02	3244±521.2	3225.2±548.2	0.2
Breech	48.3±2.8	49.2±2.3	0.0001	3100±587.2	3231.8±542.5	0.0001
Nuchal cord	49.6±1.6	49.2±2.4	0.0001	3253.6±438.3	3226.4±550.2	0.2
Multigravidity	49.1±2.5	49.3±2.1	0.0001	3210.6±578.6	3244.9±509.4	0.006
Multiparity	49±2.6	49.3±2.2	0.0001	3186.6±594.7	3244.3±522.1	0.0001

Note: GDM (gestational diabetes mellitus), PROM (premature rupture of membrane).

Table 5: Obstetric complications and twins neonatal birth length and weight

Obstetric complications	Birth length Mean±SD		p-value	Birth weight Mean±SD		p-value
	Yes	No		Yes	No	
Placenta Previa	47.0±1.4	47.03±2.2	0.9	2725 ±247.4	2582.6 ±343	0.5
GDM	48.1±0.69	46.9±2.2	0.1	2764.2±156.6	2576.5±345.8	0.1
PROM	45.7±4.9	47.0±2	0.1	2344.3±651.2	2596.2±318	0.04
Scar uterus	48.4±1.1	46.9±2.2	0.03	2890.9±251	2563±337.6	0.002
Breech	46.1±6	47±2	0.3	2585±707.4	2584.3±325.2	0.9
Multigravidity	47.2±2.4	46.8±2.1	0.2	2635.3±355.6	2550.8±330	0.1
Multiparity	48±1.2	46.8±2.3	0.02	2756.5±304.7	2557.2±340.4	0.009

Note: GDM (gestational diabetes mellitus), PROM (premature rupture of membrane).

Table 6: Multiple linear regressions of maternal factors and obstetric complications with singletons birth length and weight

Variables	Birth length			Birth weight		
	B	95%CI	p-value	B	95%CI	p-value
Maternal age	------	----------	-------	5.2	2.3 – 7.9	0.0001
WBP	0.017	0.012 – 0.022	0.0001	5.7	4.6 – 6.9	0.0001
GWG	0.1	0.089 – 0.116	0.0001	29.6	26.6 – 32.6	0.0001
Preeclampsia	-2.8	-3.1 – -2.5	0.0001	-584.3	-651.5 – -517.0	0.0001
Placenta Previa	-1.1	-1.4 – -0.9	0.0001	-340.3	-406.2 – -275.1	0.0001
Oligohydramnios	-0.8	-1.1 – -0.5	0.0001	-248.0	-311.0 – -185.4	0.0001
GDM	0.37	0.14 – 0.6	0.001	163.3	112.1 – 214.8	0.0001
PROM	-0.8	-0.98 – -0.63	0.0001	-218.3	-257.9 – -178.7	0.0001
Breech	-0.9	-1.2 – -0.6	0.0001	-146.5	-213.8 – -79.6	0.0001
Nuchal cord	0.2	0.05 – 0.47	0.01	--------	----------	--------
Multigravidity	-0.1	-0.2 – 0.02	0.09	--------	----------	--------
Multiparity	-0.1	-0.2 – 0.004	0.05	-48.1	-80.7 – -25.5	0.0001

Note: WBP (Weight before pregnancy), gestational weight gain (GWG), GDM (gestational diabetes mellitus), PROM (premature

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rupture of membrane). B = regression coefficient; CI = confidence interval; ----- = excluded with p value >0.1.

Table 7: Multiple linear regressions of maternal factors with twins birth length and weight

Variables	Birth length			Birth weight		
	B	95%CI	p-value	B	95%CI	p-value
Maternal age	0.08	0.004 – 0.16	0.03	15.0	3.5 – 26.4	0.01
Parity	0.9	0.003 – 1.9	0.04	175.3	32.1 – 318.4	0.01
GWG	-------	----------	-----	25.7	11.4 – 39.9	0.0001

Note: gestational weight gain (GWG)B = regression coefficient; CI = confidence interval; ----- = excluded with p value >0.1.

In the twin population, the most common obstetric complication was scar uterus (6.5%) followed by PROM (4.7%), GDM (4.1%), breech (3.6%), and placenta previa (1.2%) (Table1).

Maternal factors and singleton neonatal birth outcomes

Maternal factors such as WBP and GWG were significantly positively correlated ($p<0.05$) with neonatal birth length and weight. In addition, maternal age was also significantly positively correlated ($p<0.05$) with neonatal birth weight, however, no statistically significant correlation ($p>0.05$) was found with neonatal birth length (Table 2).

Maternal factors and twin neonatal birth outcome

Maternal age and WBP had a significant positive correlation ($p<0.05$) with neonatal length and weight. Moreover, GWG had a significant positive correlation ($p<0.05$) with neonatal birth weight, but no statistically significant correlation ($p>0.05$) was found with neonatal birth length (Table 3).

Obstetric complications and singleton neonatal birth outcome

The significant differences ($p<0.05$) were found between those with obstetric complications such as pre-eclampsia, placenta previa, oligohydramnios, gestational diabetes mellitus, premature rupture of membrane, breech, multigravidity, and multiparity, and without these complications in the mean neonatal birth length and weight. Furthermore, significant differences ($p<0.05$) were present in the mean neonatal birth length but no significant ($p>0.05$) differences were found in the mean neonatal birth weight of those with and without scar uterus and nuchal cord (Table 4).

Obstetric complications and twin neonatal birth outcome

There was a significant ($p<0.05$) difference in the mean neonatal birth length, and weight of those with and without scar uterus. In addition, a significant ($p<0.05$) difference was observed in the mean neonatal birth weight of those having PROM and without PROM. On the other hand, no significant difference ($p>0.05$) was found in the mean neonatal birth length of those with and without PROM (Table 5).

Association of maternal factors and obstetric complications with singleton neonatal birth outcome

The multiple linear regressions of maternal factors and obstetric complications depict that WBP, GWG, and GDM were significantly positive ($p<0.05$) associated with the neonatal birth length and weight. In contrast, preeclampsia, placenta previa, oligohydramnios, PROM, breech, and multiparity had a significantly negative ($p<0.05$) association with neonatal birth length and weight. Maternal age was significantly positive ($p<0.05$) associated with only neonatal birth weight. Similarly, the nuchal cord was significantly positive ($p<0.05$) associated with neonatal birth length (Table 6).

Association of maternal factors and obstetric complications with twin neonatal birth outcomes

Based on these results, there was a significant positive ($p<0.05$) association between maternal age and multiparity with neonatal birth length and weight. Moreover, GWG was significantly positive ($p<0.05$) associated with only neonatal birth weight (Table 7).

Discussion

In the present study, we assessed the obstetric complications in singleton and twin gestations; and the association of maternal factors and obstetrical complications with neonatal birth outcomes. Our study indicates that women with singleton gestation have an increased rate of placenta previa, preeclampsia, scar uterus, PROM, nuchal cord, oligohydramnios, and gestational diabetes mellitus compared to women with twin gestation. However, a higher frequency of cesarean section and breech were found in twin gestation compared to singleton gestation. Furthermore, obstetrical complications had a more adverse effect on singleton neonatal outcomes compared to twin birth outcomes.

Prevalence of obstetric complications in singleton vs twin gestation

We observed that women with twin gestation had a higher rate of cesarean section (97% vs 61%) than singleton gestation. The study conducted by Su et al.[28] reported a higher rate of cesarean delivery in women with twin gestation (85.8%) than those in women with singleton gestation (42.6%). Moreover, Chiwanga et al.[29] found 42.6% cesarean delivery in twins and 32.4% in singleton gestation. These findings are in line with our results. Scar uterus is defined in our study when women have already experienced C-section. Among obstetric complications, the most common was scar uterus in singleton gestation (15%) and twin gestation (6.5%). A survey conducted by World Health Organization (WHO) in 24 countries from 2004 to 2008 reported that China had the highest C-section rate (46.2%) among the 24 countries in the survey[30]. Compared to singleton gestation, twin gestation had less prevalence of premature rupture of membrane. A study conducted by Rujiwetpongstorn[31] found that the prevalence of premature rupture of membrane in twin gestation had a lower tendency than that in singleton gestation. On the other hand, Obiechina et al.[32] reported a higher frequency of premature rupture of membrane in twin gestation compared

to singleton gestation.

We found that women with a singleton gestation, compared with those having twin gestation, have a higher rate of GDM. Similar results were found by Rebarber et al.[33] and Kai et al.[20] in their studies. However, Weissman et al.[34] showed a high prevalence of GDM in twin gestation compared to singleton gestation. The incidence of placenta previa was higher in singleton compared to twin gestation. Two case-control studies conducted by Mizrahi et al.[35] and Spellacy et al.[36] reported either lower or similar prevalence of placenta previa in singleton and twin gestation. In contrast, Ananth et al.[37] showed a higher incidence of placenta previa in twins compared with a singleton gestation. A study conducted by Sabzehei et al.[38] reported that the prevalence of preeclampsia was higher in twin gestation than that in singleton gestation. In addition, Bdolah et al.[39] also found a higher incidence of pre-eclampsia in twin gestation compared to singleton gestation. However, in comparison to twin gestation, we found a higher prevalence of preeclampsia in singleton gestation. It might be due to the small size of the twin population compared to the singleton population. For 3-4% of term gestation, the fetus could be in the breech presentation[40]. In our study, we found breech presentation 2.9% for singleton and 3.6% for twin term gestation.

Maternal factors, obstetric complications, and singleton birth weight and length

Maternal age is the most important predictor for successful female fertility outcome[24]. We found a significantly positive ($p<0.05$) association between maternal age and neonatal birth weight rather than neonatal birth length. While Kirchengast et al.[24] and Veghari[41] have seen a positive association of maternal age with both neonatal weight and length. The neonatal birth weight and birth length were found to be highly significantly positive associated with maternal pre-pregnancy body weight and gestational weight gain. Moreover, a significantly positive association between maternal pre-pregnancy body weight, gestational weight gain, and newborn size has been reported in the present study. In general, neonatal birth length and birth weight increased with increasing gestational weight gain independent of maternal age and pre-pregnancy weight status. The study conducted by Polzlberger et al.[25] has also found a significant positive association of maternal pre-pregnancy weight and gestational weight gain with neonatal birth length and weight. Neonates born to multiparous women with low birth weight are not surprising. We found that neonatal birth weight was significantly negative ($p<0.05$) associated with multiparity. Inconsistent with our findings, Yilgwan et al.[42] has reported the negative association of multiparity with neonatal birth weight.

It has widely known that preeclampsia has a significant impact on fetal growth[43]. The previous studies carried out by Xiong et al.[44] and Bozdag et al.[45] have found a significant negative association between preeclampsia and neonatal birth weight. However, in another study, Xiong et al.[46] reported no negative significant association between preeclampsia and neonatal birth weight. These studies have only documented the association of preeclampsia with neonatal birth weight but we reported a significant ($p<0.05$) negative association of preeclampsia with both neonatal birth weight and length. No such studies have been found to show the association of preeclampsia with neonatal birth length. We have found that placenta previa has a significantly negative ($p<0.05$) association with neonatal birth weight and length. Likewise, several previous studies have documented the significant negative association of placenta previa with neonatal birth weight and length, which is parallel with our findings[47]. In contrast, some studies have found no negative association of placenta previa with neonatal birth weight and length[48].

It is well known that oligohydramnios is significantly associated with a higher risk of low birth weight[49] and IUGR[50]. There was a significant negative association ($p<0.05$) of oligohydramnios with neonatal birth weight and length in our study. This result is inconsistent with earlier findings[51]. The exposure of the fetus to increase maternal glucose supply stimulates fetal pancreatic insulin production, which causes accelerated fetal growth[52]. However, the level of some circulating nutrients, such as free fatty acids (FFA) and triglycerides (TG) are elevated in GDM and may also contribute to fetal growth[53]. We found that gestational diabetes mellitus was significantly positive ($p<0.05$) associated with neonatal birth weight and length. The study conducted by Bystrom et al.[54] reported that GDM has a positive effect only on neonatal birth length but not on neonatal birth weight. On the other hand, Alberico et al.[55] found that gestational diabetes mellitus was significantly positively associated with high neonatal birth weight.

PROM was significantly negative ($p<0.05$) associated with neonatal birth weight and length in our study. Moreover, Endale et al.[21] revealed that premature rupture of membrane has a significantly negative effect on neonatal birth weight. However, no more studies have been found to show the effect of PROM on neonatal birth weight and length. So far, no more previous studies have determined the association of breech presentation with neonatal birth weight and length. However, only Luterkort et al.[23] has reported that breech presentation has a significant negative effect only on neonatal birth weight, not on neonatal birth length. We also found that breech presentation has a significantly negative ($p<0.05$) association with neonatal birth weight and length. Umbilical cord complication, such as the nuchal cord at the time of birth, was significantly positive ($p<0.05$) associated with neonatal birth length rather than neonatal birth weight. Likewise, Mastrobattista et al.[56] reported that there was no significant association of the nuchal cord with neonatal birth weight. However, the study conducted by Schaffer et al.[57] found that the nuchal cord was significantly negatively associated with neonatal birth weight.

Maternal factors, obstetric complications, and twin birth weight and length

Our results indicate that maternal age was significantly positive ($p<0.05$) associated with twins' neonatal birth weight and length. Delbaere et al.[58] also found the positive effect of maternal age on twins' neonatal birth weight. However, Oakley et al.[59] documented the negative association of maternal age with twins' neonatal birth weight. Our findings indicated that in twin gestation, maternal multiparity has a significant positive influence on twin's neonatal birth weight and length. As in the previous study[60] the association of maternal multiparity was significantly positive with twin birth weight, suggesting that the uteri of multiparous women are more efficient in nurturing and promoting the intrauterine growth of twins. Quite interestingly, no previous studies have documented the association of multiparity with twin's birth length but we reported the positive association of maternal multiparity with both twin's birth weight and length. Our study supports previous reports on neonatal

outcomes and gestational weight gain in twin gestation. In the prior studies[61], there was a significant positive association of gestational weight gain with neonatal birth weight. In contrast to our study findings, a prospective cohort of twin gestations found no association between gestational weight gain and neonatal birth weight[62].

In our present study, there was no obstetrical complication associated with twins' birth weight and length. It might be due to the small sample size of the twin population and secondly, we included only term twin for the study. It is stated that about 50% of twin pregnancies deliver preterm neonates due to necrotizing enterocolitis, respiratory distress syndrome, intraventricular hemorrhage, and sepsis[63]. Therefore, it suggests that most often in term gestation, twin neonates born are healthier in terms of birth weight and length.

Limitations of the study

Our study had certain limitations. To eliminate the effect of preterm birth on neonatal birth size, we confined our analysis to only term birth, which is the potential selection bias in our analysis. Moreover, the study was conducted in only one tertiary hospital. So, our results cannot be generalized to the whole population.

Conclusion

It is summarized that in term gestation, maternal factors and obstetric complications were significantly associated with singleton birth weight and length. However, only maternal factors were significantly associated with twin neonatal birth weight and length rather than obstetric complications in term gestation. Furthermore, an increased rate of obstetrical complications has been found in women with singleton gestation compared to twin gestation. It is recommended that a large population-based study should be conducted to verify our findings and explore the influence of obstetrical complications on neonatal birth weight and length in particular in term twin gestation.

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Disclosure of interest

All the authors declare no conflict of interest.

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