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Original Research

Association of Parity and Previous Birth Outcome With Brachial Plexus Birth Injury Risk

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OBJECTIVE: To evaluate the association of maternal delivery history with a brachial plexus birth injury risk in subsequent deliveries and to estimate the effect of subsequent delivery method on brachial plexus birth injury risk.

METHODS: We conducted a retrospective cohort study of all live-birth deliveries occurring in California-licensed hospitals from 1996 to 2012. The primary outcome was recurrent brachial plexus birth injury in a subsequent pregnancy. The exposure was delivery history (parity, shoulder dystocia in a previous delivery, or previously delivering a neonate with brachial plexus birth injury). Multiple logistic regression was used to model adjusted associations of delivery history with brachial plexus birth injury in a subsequent pregnancy. The adjusted risk and adjusted risk difference for brachial plexus birth injury between vaginal and cesarean deliveries in subsequent pregnancies were determined, stratified by delivery history, and the number of cesarean deliveries needed to prevent one brachial plexus birth injury was determined.

RESULTS: Of 6,286,324 neonates delivered by 4,104,825 individuals, 7,762 (0.12%) were diagnosed with a brachial plexus birth injury. Higher parity was associated with a 5.7% decrease in brachial plexus birth injury risk with each subsequent delivery (adjusted odds ratio [aOR] 0.94, 95% CI 0.92–0.97). Shoulder dystocia or brachial plexus birth injury in a previous delivery was associated with fivefold (0.58% vs 0.11%, aOR 5.39, 95% CI 4.10–7.08) and 17-fold (1.58% vs 0.11%, aOR 17.22, 95% CI 13.31–22.27) increases in brachial plexus birth injury risk, respectively. Among individuals with a history of delivering a neonate with a brachial plexus birth injury, cesarean delivery was associated with a 73.0% decrease in brachial plexus birth injury risk (0.60% vs 2.21%, aOR 0.27, 95% CI 0.13–0.55) compared with an 87.9% decrease in brachial plexus birth injury risk (0.02% vs 0.15%, aOR 0.12, 95% CI 0.10–0.15) in individuals without this history. Among individuals with a history of brachial plexus birth injury, 48.1 cesarean deliveries are needed to prevent one brachial plexus birth injury.

CONCLUSIONS: Parity, previous shoulder dystocia, and previously delivering a neonate with brachial plexus birth injury are associated with future brachial plexus birth injury risk. These factors are identifiable prenatally and can inform discussions with pregnant individuals regarding brachial plexus birth injury risk and planned mode of delivery.

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Brachial plexus birth injury is a birth condition resulting from traction on the nerve roots of the brachial plexus during labor and delivery. It is among the most common birth injuries, occurring in about 1.5 per 1,000 live births,[1–3] and presents as

upper-extremity weakness or paralysis. Although the majority of affected neonates recover spontaneously, up to 30% have incomplete or absent neurologic recovery (permanent brachial plexus birth injury),[4–8] with persistent motor weakness, sensory deficits,[4–9] and impaired musculoskeletal development, including joint contractures and skeletal dysplasia,[10,11] attributable to chronic denervation during growth. Long term, children may experience functional limitations,[12–14] pain,[15–17] and psychosocial impairments[12,14,18] that persist into adulthood.[19]

It is often assumed that pregnancy history (parity, previous shoulder dystocia, or history of brachial plexus birth injury) is associated with brachial plexus birth injury risk; however, this has not been definitively established. The evidence for the effect of parity on brachial plexus birth injury risk is inconsistent, with some prior studies demonstrating an increased brachial plexus birth injury risk with higher parity, and others demonstrating a decreased risk.[20–29] Similarly, only small case series have evaluated the effect of shoulder dystocia in a prior delivery or previous brachial plexus birth injury on brachial plexus birth injury risk in subsequent pregnancies.[24,30,31] Although pregnancy history is a potentially potent source of information on the risk of brachial plexus birth injury, an evidence gap remains regarding the relationship between pregnancy history and future brachial plexus birth injury risk. Understanding this relationship could inform preventive strategies and ultimately provide insight into the mechanism by which brachial plexus birth injuries occur.

The purpose of this study was to evaluate whether previous pregnancy history, including parity, history of shoulder dystocia, or brachial plexus birth injury in a previous pregnancy, was associated with brachial plexus birth injury risk in subsequent pregnancies. In addition, we sought to estimate the reduction in brachial plexus birth injury risk with cesarean delivery in subsequent pregnancies.

METHODS

This study was approved by the University of California, Davis, IRB and the California Committee for the Protection of Human Subjects. Using the Linked Birth Files from California's Department of Health Care Access and Information created to facilitate research on pregnancy outcomes,[32–38] we conducted a retrospective cohort study of all maternal–live-birth neonatal pairs whose childbirth occurred in a nonfederal California-licensed hospital from 1996 to 2012, accounting for 98% of California births.[38] The data were compiled by Department of Health Care Access and Information from the California Inpatient Discharge Dataset, Birth Certificate Dataset, and Vital Statistics Birth Cohort File. Data included maternal demographic and health data for 9 months before and 12 months after delivery, linked to the neonate's demographic and health data from birth through the first year of life.[32–36] Individuals who delivered more than once during the study interval were identified by a unique identifier. Previous studies report the accuracy of this data set for maternal factors, intrapartum events, and obstetric complications.[39–41]

The study cohort included all maternal–neonatal pairs in whom the neonate had an International Classification of Diseases, Ninth Revision (ICD-9) code indicating live birth (V30, V31, V33, V34, V36, V37, V39). Stillborn fetuses and unlinked mothers or neonates were excluded. Demographic factors in the data set were obtained from inpatient discharge data and included maternal age, neonatal sex, and race and ethnicity for both mother and neonate as reported by the mother. Missing or unknown ethnicity was imputed as non-Hispanic for both the mother and neonate. Mothers younger than age 13 years and older than age 50 years were excluded. Age was categorized as 19 years or younger, 20–34 years, and 35 years or older. Missing maternal age at a given birth was imputed using the age at previous or subsequent births and the date of birth of the neonate. The primary outcome, recurrent brachial plexus birth injury in a subsequent pregnancy, was identified with ICD-9 codes (767.6 or 953.4). The exposure was delivery history (parity, shoulder dystocia in a previous delivery, or previously delivering a neonate with brachial plexus birth injury) and present delivery method (vaginal or cesarean), which were available in the data set. Shoulder dystocia in a previous delivery and having a previous neonate with brachial plexus birth injury were identified by the use of unique maternal identifiers and evaluation of all deliveries associated with that mother during the study interval.

Descriptive statistics were calculated for maternal and neonatal demographic factors and maternal pregnancy history. The incidence of brachial plexus birth injury was determined for primiparous patients, all multiparous patients, multiparous patients without a history of shoulder dystocia or brachial plexus birth injury in a previous delivery, multiparous patients with shoulder dystocia only (not brachial plexus birth injury) in a previous delivery, and multiparous patients who delivered a previous neonate with brachial plexus birth injury.

Multiple logistic regression was used to model adjusted associations with brachial plexus birth injury.

When examining parity as the exposure, we adjusted for race, ethnicity, age, delivery method (vaginal or cesarean), and delivery year because these covariates are identifiable prenatally and have been associated with brachial plexus birth injury in previous studies.[1–3,28] The analysis was restricted to individuals with more than one birth over the study interval when modeling brachial plexus birth injury risk associated with shoulder dystocia or brachial plexus birth injury in a previous delivery. These models adjusted for parity and the covariates listed previously. Effect modification of mode of delivery by maternal brachial plexus birth injury history was evaluated by adding to the model an interaction term for the product of these binary indicators. Maternal clustering effects on standard errors, which we found previously to be negligible,[3] were not considered for computational feasibility.

The method of recycled predictions[42] was used to compare the adjusted predicted probability of brachial plexus birth injury for vaginal and cesarean deliveries, with predictive margins used to statistically balance the covariate distributions between these two delivery modes.[43] This method allows us to estimate an average probability (adjusted risk) of brachial plexus birth injury with different delivery methods and different delivery histories while holding the other variables (race, ethnicity, age, and delivery year) constant. The adjusted risk and adjusted risk difference for brachial plexus birth injury between delivery modes were determined for four groups: all multiparous patients, multiparous patients without a history of shoulder dystocia or brachial plexus birth injury in a previous delivery, multiparous patients with shoulder dystocia only in previous deliveries (without brachial plexus birth injury), and multiparous patients who delivered previous neonate(s) with brachial plexus birth injury. The number of cesarean deliveries needed to prevent one brachial plexus birth injury for each group was calculated as 1/adjusted risk difference. All statistical analysis was performed with SAS 9.4. Significance was established at $P<.05$.

RESULTS

The study cohort included 6,286,324 neonates born to 4,104,825 individuals; 1,334,954 individuals contributed a single birth to the cohort, and 2,769,871 contributed multiple births. The mean number of neonates per individual was 1.53±0.83. In total, 7,762 neonates were diagnosed with brachial plexus birth injury (1.23 brachial plexus birth injury per 1,000 live births). Maternal and neonatal demographic characteristics are included in Table 1; the association of these demographic characteristics with brachial plexus birth injury has been published previously.[3] Pregnancy and delivery characteristics are included in Table 2. Brachial plexus birth injury incidence and probability by pregnancy history and delivery method are included in Table 3.

Table 1. Demographic Characteristics of the Study Cohort (N=6,286,324 Neonates Delivered)

Characteristic	Value
Maternal	
Age (y)	28.3±6.2
Age category (y)	
Younger than 19	506,964 (8.06)
20–34	4,905,359 (78.03)
35 or older	874,001 (19.3)
Race	
Asian	718,588 (11.43)
Black	325,949 (5.19)
Native American	28,509 (0.45)
White	4,095,319 (65.15)
None of the above	1,117,959 (17.78)
Ethnicity (n=6,239,875)	
Hispanic	2,723,422 (44.06)
Non-Hispanic	3,516,453 (55.94)
Neonatal	
Sex	
Male	3,181,664 (50.61)
Female	3,104,612 (49.39)
Race (n=6,286,321)	
Asian	688,770 (10.96)
Black	319,012 (5.07)
Native American	27,506 (0.44)
White	4,126,162 (65.64)
None of the above	1,124,871 (17.89)
Ethnicity	
Hispanic	2,667,685 (42.44)
Non-Hispanic	3,618,639 (57.56)

Data are mean±SD or n (%).

Parity was associated with a 5.7% decrease in the odds of brachial plexus birth injury with each subsequent delivery (adjusted odds ratio [aOR] 0.94, 95% CI 0.92–0.97). Shoulder dystocia in a previous delivery was associated with fivefold increased odds of subsequent brachial plexus birth injury (aOR 5.39, 95% CI 4.10–7.08), and a history of brachial plexus birth injury was associated with a 17-fold increase in the odds of brachial plexus birth injury in subsequent pregnancies (aOR 17.22, 95% CI 13.31–22.27) (Table 4). We identified a significant interaction between history of brachial plexus birth injury and delivery method ($P<.033$), indicating that the effect of this history on the risk of subsequent brachial plexus birth injury varied by delivery method. Among individuals with a history of brachial plexus birth injury, subsequent cesarean delivery was

Table 2. Pregnancy History and Delivery Characteristics

	Total	No. With BPBI	BPBI Incidence/1,000 Live Births (95% CI)
Total live births	6,286,324	7,762	1.23 (1.21–1.26)
Parity			
Primiparous	3,516,453 (55.94)	4,585	1.30 (1.27–1.34)
Multiparous	2,769,871 (44.06)	3,177	1.15 (1.11–1.19)
No. of previous deliveries			
0	3,516,453 (55.94)	4,585	1.30 (1.27–1.34)
1	1,757,348 (27.96)	2,120	1.20 (1.16–1.26)
2	696,987 (11.09)	718	1.03 (0.96–1.11)
3	217,198 (3.46)	239	1.10 (0.96–1.24)
4	64,713 (1.03)	62	0.96 (0.72–1.20)
5 or more	33,625 (0.53)	38	1.13 (0.77–1.49)
Previous shoulder dystocia	9,072 (0.14)	53	5.84 (4.28–7.41)
Previous BPBI	3,872 (0.052)	62	16.01 (12.06–19.97)
Delivery method in subsequent pregnancy*			
Vaginal	4,176,399 (66.44)	5,723	1.37 (1.34–1.41)
VBAC	71,000 (1.13)	128	1.80 (1.49–2.12)
Instrumented vaginal	359,483 (5.72)	1,501	4.18 (3.97–4.39)
Instrumented VBAC	9,772 (0.16)	44	4.50 (3.18–5.83)
Primary cesarean	915,149 (14.56)	269	0.29 (0.26–0.33)
Repeat cesarean	754,507 (12.00)	97	0.13 (0.10–0.15)

BPBI, brachial plexus birth injury; VBAC, vaginal birth after cesarean.
Data are n (%) unless otherwise specified.
* Delivery method was unknown for 14 individuals.

associated with a 73% decrease brachial plexus birth injury risk (aOR 0.27, 95% CI 0.13–0.55) compared with vaginal delivery. Among individuals without a history of brachial plexus birth injury, cesarean delivery in a subsequent pregnancy was associated with an 87.9% decrease in brachial plexus birth injury (aOR 0.12, 95% CI 0.10–0.15) (Table 4).

The adjusted risk of brachial plexus birth injury was lower in cesarean compared with vaginal deliveries in all groups: all multiparous patients, multiparous patients with neither shoulder dystocia nor brachial plexus birth injury in a previous delivery, multiparous patients with previous shoulder dystocia only, and multiparous patients with previous brachial plexus birth injury (Table 5). Among all multiparous patients, the adjusted risk difference of cesarean compared with vaginal delivery was 131 fewer brachial plexus birth injuries per 100,000 births, indicating that 758 cesarean deliveries are needed to prevent one brachial plexus birth injury. Among multiparous patients without prior shoulder dystocia or brachial plexus birth injury in a previous delivery, 785 cesarean deliveries are needed

Table 3. Probability of Brachial Plexus Birth Injury by Pregnancy History and Delivery Method*

	Vaginal Delivery			Cesarean Delivery		
	No. of BPBIs/Total	Incidence/1,000 Live Births (95% CI)	Integer Rounded Probability	No. of BPBIs/Total	Incidence/1,000 Live Births (95% CI)	Integer Rounded Probability
Primiparous patients	4,361/2,598,937	1.68 (1.63–1.73)	1 in 596	224/917,506	0.24 (0.21–0.28)	1 in 4,098
Multiparous patients	3,035/2,017,717	1.50 (1.46–1.56)	1 in 665	142/752,150	0.19 (0.16–0.22)	1 in 5,291
Previous BPBI†	52/2,353	22.11 (16.16–28.04)	1 in 45	9/1,510	5.96 (2.08–9.84)	1 in 168
Previous shoulder dystocia but no previous BPBI	41/6,318	6.49 (4.51–8.47)	1 in 154	0/2,094	0	—
No prior shoulder dystocia or BPBI	2,942/2,009,046	1.46 (1.41–1.52)	1 in 683	133/748,546	0.18 (0.15–0.21)	1 in 5,618

BPBI, brachial plexus birth injury.
* The 14 individuals with an unknown mode of delivery were excluded from this table.
† Includes individuals with previous BPBI with or without previous shoulder dystocia. There were 655 deliveries in this row to individuals with previous BPBI with shoulder dystocia. Of these deliveries, there were 12 BPBI cases in 351 vaginal deliveries and 0 BPBI cases in 304 cesarean deliveries.

Table 4. Odds Ratios for Brachial Plexus Birth Injury by Pregnancy History

	No BPBI (n=6,278,562)	BPBI (n=7,762)	OR (95% CI)*	aOR (95% CI)†
Entire cohort				
Increasing parity	0.68±0.96	0.61±0.92	0.93 (0.90–0.95)	0.94 (0.92–0.97)
Births to multiparous patients only‡	n=2,766,694	n=3,177		
Previous shoulder dystocia	9,014 (0.33)	53 (1.67)	5.19 (3.95–6.82)	5.39 (4.10–7.08)
Previous BPBI	3,802 (0.14)	61 (1.92)	14.23 (11.02–18.37)	17.22 (13.31–22.27)
No previous BPBI (n=2,766,004)	2,762,888 (99.89)	3,116 (0.11)		
Cesarean delivery	750,507 (27.16)	133 (4.27)	0.12 (0.10–0.14)	0.12 (0.10–0.15)
Vaginal delivery	2,012,381 (72.84)	2,983 (95.73)	Ref	Ref
Previous BPBI (n=3,863)	3,802 (98.42)	61 (1.58)		
Cesarean delivery	1,501 (39.48)	9 (14.75)	0.27 (0.13–0.54)	0.27 (0.13–0.55)
Vaginal delivery	2,301 (60.52)	52 (85.25)	Ref	Ref

BPBI, brachial plexus birth injury; OR, odds ratio; aOR, adjusted odds ratio; Ref, referent.
Data are mean±SD or n (column %) unless otherwise specified.
* Each reported OR is statistically significant ($P<.05$). In addition, the interaction term for previous BPBI and cesarean delivery was statistically significant, implying that the adjusted ORs for cesarean delivery differ for deliveries from a mother with a previous BPBI and those from a mother with no previous BPBI.
† Rows report adjusted OR for each pregnancy history factor. A separate multiple logistic regression model was fit for each pregnancy history factor. All models included age, race, ethnicity, year of birth, and parity as independent variables. For mode of delivery, the multiple logistic regression model was fit on all multiparous patient births and included a main effect for previous BPBI and an interaction term for previous BPBI and cesarean delivery.
‡ In the multiparous patient birth subgroup, the column percentages for mode of delivery are computed separately based on whether there was a history of BPBI.

to prevent one brachial plexus birth injury. Among multiparous patients with prior shoulder dystocia, 185 cesarean deliveries are needed to prevent one brachial plexus birth injury. Among individuals with a history of a neonate with brachial plexus birth injury, 48 cesarean deliveries are needed to prevent one brachial plexus birth injury. For all groups, the adjusted risk difference between cesarean and vaginal delivery was significant ($P>.001$) (Table 5).

DISCUSSION

Brachial plexus birth injury is often considered an unpredictable event[20–22,44] because many risk factors are not identifiable prenatally (shoulder dystocia, prolonged labor, instrumented delivery, fetal macrosomia)[45–48] and those that are (maternal obesity, pregnancy weight gain, gestational diabetes) are poorly predictive of brachial plexus birth injury.[45,46,49,50] Our findings indicate that delivery history is a valuable source of information on future brachial plexus birth injury risk. We found that both history of shoulder dystocia and history of prior brachial plexus birth injury were strongly associated with brachial plexus birth injury in subsequent births. In addition, parity is associated with a 6% decrease in brachial plexus birth injury risk with each subsequent pregnancy. Although cesarean delivery is associated with a lower brachial plexus birth injury risk, it does not eliminate brachial plexus birth injury risk, and the protective effect of cesarean delivery varies by delivery history.

Table 5. Adjusted Risk and Adjusted Risk Difference of Brachial Plexus Birth Injury in Vaginal and Cesarean Deliveries by Delivery History Among Multiparous Patients (per 100,000 Live Births)

	n	Cesarean Delivery*	Vaginal Delivery*	ARD (95% CI)	NNP†	*P*
All multiparous patients	2,769,871	18.9±12.0	150.3±93.3	131.4 (131.3–131.5)	757.6	<.001
No prior shoulder dystocia or BPBI	2,757,596	18.3±4.5	145.8±36.1	127.4 (127.4–127.5)	784.9	<.001
Previous shoulder dystocia	8,412	78.4±16.7	620.2±131.1	541.8 (539.4–544.3)	184.6	<.001
Previous BPBI	3,863	306.7±72.7	2,387.3±552.2	2,080.6 (2,065.5–2,095.8)	48.1	<.001

ARD, adjusted risk difference; NNP, number needed to prevent; BPBI, brachial plexus birth injury.
Data are adjusted risk±SD unless otherwise specified.
* Estimated as predictive margins.
† Number of cesarean deliveries to prevent one BPBI.

On the basis of small historical case series, it is often assumed that a history of shoulder dystocia or delivering a neonate with brachial plexus birth injury is associated with an increased risk of brachial plexus birth injury,[20,24,30] but to the best of our knowledge, there are no prior large longitudinal cohort studies that rigorously evaluated the association of shoulder dystocia or brachial plexus birth injury in a previous delivery with brachial plexus birth injury risk in a subsequent pregnancy. This evidence gap is likely attributable to the fact that most single-institution case series are unlikely to have sufficient numbers of individuals who have delivered a single or multiple neonates with brachial plexus birth injury and do not follow up individuals longitudinally and thus are unable to follow up subsequent deliveries or identify individuals who gave birth to an affected neonate at a different hospital. Given that up to 50% of affected families pursue litigation in brachial plexus birth injury deliveries,[51–53] it is plausible that individuals who deliver an affected neonate deliver subsequent children at a different facility. Because our data set includes all births at California-licensed hospitals, we are able to ascertain additional births associated with an individual even if they occurred at a different institution, as long as that subsequent birth occurred in California.

Previous studies evaluating the relationship of parity and brachial plexus birth injury report conflicting results,[20–22,28,29,54,55] including a reported increased risk in primiparous patients,[26,28] in multiparous patients,[55] or no difference related to parity.[22] Contradicting results from prior studies are difficult to interpret. Perhaps parity acts differently in different individuals, and the small, single-center (and potentially homogeneous) cohorts in previous studies reflect those differential effects. Alternatively, small cohorts may be underpowered to detect the effect size of parity. In addition, many studies use univariate analyses that do not control for covariates or control for covariates that are not known prenatally (eg, shoulder dystocia, operative vaginal delivery). Our study design overcomes many of these limitations by including a large, diverse cohort powered to detect small effect sizes, longitudinal data over 17 years that allow assessment of subsequent pregnancies, and the capacity to control for important covariates.

We observed that cesarean delivery decreases but does not eliminate brachial plexus birth injury risk, consistent with previous studies.[56,57] In particular, the probability of an individual with previous brachial plexus birth injury having a subsequent affected neonate was 1 in 45 with a vaginal delivery and 1 in 168 with a cesarean delivery. The finding that cesarean delivery does not completely eliminate brachial plexus birth injury risk suggests the possibility of alternative risk factors other than those associated with traversing the birth canal, including in utero injury.[48,56,58] Augustine et al[57] identified a higher risk of brachial plexus birth injury in emergency compared with elective cesarean deliveries and hypothesized that unfavorable intrauterine positioning may result in excessive force on the brachial plexus. These findings can inform discussions between clinicians and individuals with this delivery history regarding brachial plexus birth injury risk in subsequent pregnancies. Clinician–patient conversations should be based in shared decision making and include a discussion of the other well-established short- and long-term risks of cesarean delivery for both the pregnant individual and child.[59,60]

Study limitations include the retrospective design and limitations inherent in the use of administrative data sets, including that the data set used was created for medical billing and resource allocation, so some variables potentially relevant to brachial plexus birth injury risk (eg, maternal weight gain, body mass index, medical comorbidities, and estimated fetal weight) were not available. We limited the scope of our analyses to characteristics that can be identified prenatally; consequently, we did not analyze the effect of factors such as birth weight and operative vaginal delivery. Our cohort included only neonates diagnosed with brachial plexus birth injury at birth, so we may have missed neonates with mild injuries not diagnosed at birth and likely included neonates with brachial plexus birth injury that ultimately resolved. However, because brachial plexus birth injury is commonly diagnosed at birth, is not easily confused with other diagnoses, has unique ICD-9 codes, and does not require confirmatory testing, we believe the accuracy for this diagnosis is high. Another limitation is that, in the early years of the data set, multiparous patients may have delivered before the onset of data linkage and their delivery histories would not be included. In addition, the risk of a subsequent neonate with brachial plexus birth injury delivered vaginally is calculated from those individuals who attempted a vaginal delivery with this history, which is likely a select group and therefore introduces a selection bias. However, we believe that this bias underestimates this risk because individuals who did not undergo subsequent vaginal delivery may have had more brachial plexus birth injury risk factors and were advised against vaginal delivery.

Strengths of this study include the size of the data set, allowing us to identify associations that may not

be detectable in smaller data sets, as well as the continuous coverage of maternal–neonatal birth pairs over a 17-year period, allowing us to track individuals over time and identify many more subsequent deliveries than were captured in other studies, even if they occurred at a different institution. The accuracy of this data set for obstetric complications and birth diagnoses has been characterized in previous studies.[39–41] The use of linked maternal–neonatal data improves on studies using neonatal-only or maternal-only data, which often do not provide sufficient information to evaluate the effect of maternal history on neonatal conditions.[61,62] In addition, this data set compiles data from several sources, which allows cross-checking accuracy among overlapping variables and broader coverage from nonoverlapping variables. Another strength is the diversity of the maternal–neonatal pairs in our cohort.[63]

This investigation implies that individuals with a history of shoulder dystocia or brachial plexus birth injury in a prior pregnancy are at substantially higher risk of delivering a neonate with brachial plexus birth injury compared with those without this history. Clinicians can use this information to counsel patients on their risk of delivering an affected neonate and to discuss the risks and benefits of various delivery strategies. Further work is needed to evaluate the potential benefits of cesarean delivery in individuals at higher risk of delivering a neonate with brachial plexus birth injury while weighing the well-known risks of cesarean delivery. Lastly, the finding that cesarean delivery does not eliminate brachial plexus birth injury risk suggests risk factors for brachial plexus birth injury unrelated to trauma during vaginal delivery. Future studies evaluating brachial plexus birth injury occurring in cesarean deliveries or in individuals who deliver multiple affected neonates may provide insight into additional potential risk factors.

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