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Decreasing prevalence of cerebral palsy in birth cohorts in South Carolina using Medicaid, disability service, and hospital discharge data, 1996–2009

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Abstract

AIM—Since cross-sectional trends of 8-year-old cerebral palsy (CP) birth prevalence based on record review were stable from 1985 to 2002 in Metropolitan Atlanta, we examined birth-cohort trends using administrative data sets promptly.

METHOD—Among 755 433 live births from 1996 to 2009 in South Carolina, 2080 received CP diagnosis by age 4 years from linked Medicaid claims with International Classification of Diseases, Ninth Revision codes 343.X (contributing 1061 [51%] unique cases), hospital discharge data (57 [3%] unique cases), and Department of Disabilities and Special Needs program (64 [3%] unique cases). Trends were assessed using negative binomial regression.

RESULTS—Including 3.7 percent of cases who died before age 4 years, CP prevalence per 1000 live births decreased significantly from 3.6 in 1996 to 2.1 in 2006 (–3.0% average annual change; 95% confidence interval [–4.4 to –1.6]). The overall prevalence was 2.8 per 1000 live births, 46.0 per 1000 very-low-birthweight (VLBW) live births, and 53.0 per 1000 VLBW 1-year survivors. Disparities and downward trends persisted across subgroups with higher rates among non-Hispanic black infants than non-Hispanic white and among males compared to females.

INTERPRETATION—Downward CP prevalence rates and persistent disparities remain in South Carolina. Further research should validate this methodology, including early deaths, and develop broad surveillance systems to inform clinical practices and etiology.

Prompt monitoring of the burden and full distribution of cerebral palsy (CP) based on public health surveillance¹ and trend analyses is important,² as CP is the most common cause of motor disability in childhood, an indicator of perinatal brain injury, and hard to capture. CP trends can be examined using birth cohorts as opposed to cross-sectional designs (e.g. registries, surveys); case ascertainment should be prompt, and include mild to severe cases or cases who died in order to better understand the etiology, as well as shifts in severity over time. If built on high quality data systems and birth cohort trend analyses, further studies could then investigate etiological conditions and changes in obstetrical and pediatric practice to ascertain relationships with conditions and practices to changing trends in CP severity or incidence. This is particularly important for high-risk groups such as those born preterm whose survival rates have been increasing over time. According to Paneth et al., monitoring of CP rates per 1000 very-low-birthweight (VLBW, <1500g at birth) infants is 'the only way to obtain a sense of the net contribution of improving survival to the prevalence of CP in the population'.³ Multi-site consortia of population-based registries in two continents, initiated 30 years ago,⁴ ascertained CP diagnosis at age 5 years and reported decreased CP prevalence from 65 to 36 cases per 1000 infants at 20 to 27 weeks of gestation from 1995 to 2006 in Australia⁵ and from 70.9 to 35.9 per 1000 VLBW live births from 1980 to 2003 in Europe,⁶ but stable trends among moderately low birthweight (1500–2499g)⁷ and normal birthweight (>2500g) infants in Europe.⁸ Australian CP registries include all ages of survivors as a case,^{9,10} but have not reported counts of early deaths.

Unlike Europe or Australia, the USA currently has no population-based CP registry, most likely because of barriers that include large population sizes, poor interinstitution collaboration, and decentralized medical and social systems.^{3,11} Previously published methods (Table I) are limited to cross-sectional surveys of cases or convenience samples.^{12,13} The Metropolitan Atlanta Developmental Disabilities Surveillance Program of the Centers for Disease Control and Prevention reviewed records and estimated an increase from 1.7 10-year-olds with CP per 1000 1-year survivors in 1975 to 1977 to 2.0 3-year-olds to 10-year-olds with CP per 1000 1-year survivors for the periods 1981 to 1985 and 1986 to 1991.¹⁴ However in the spastic CP subgroup, they noted stable cross-sectional trends of 8-year-old CP survivors from 1985 to 2002 from 1.9 to 1.8 cases per 1000 1-year survivors.¹⁵ There were downward trends among Hispanic children and rates were higher for non-Hispanic black children compared to non-Hispanic white children.¹⁵ CP rates in Atlanta were stable among VLBW infant survivors.^{14,15} In northwest North Carolina, a decrease in CP trends was reported among VLBW 1-year survivors from 11.3 percent (113 per 1000) from 1982 to 1988 to 5.2% (52 per 1000) from 1990 to 1994 among children admitted to two neonatal intensive care units.¹³ The numerators in the Atlanta studies of 8-year-old CP survivors^{15,16} excluded patients with CP who died before 8 years of age. Excluding CP cases who die early may eliminate data that are informative concerning etiology and disparities, and lose cases that also may be sensitive to interventions.⁹ Despite the importance of the minimum age of survival for inclusion and the age at ascertainment as design measures (Table I),⁹ a lack of all levels of severity and cases who died before the age at ascertainment in CP trend analyses has been a serious barrier to detecting the etiology and clinical care changes in practice in the USA.

Therefore, we designed the current study to estimate birth-cohort trends in the prevalence of CP among live births across birthweight, gestational age, ethnic group, and sex. Collected by governments and other organizations for medical or social service, de-identified administrative data are readily available, relatively inexpensive, cover large populations and geographical areas over time, and include common data elements. CP prevalence or trends in live births have been assessed using claims data outside the USA (e.g. British Columbia,¹⁷ South Korea,¹⁸ and Taiwan)¹⁹ using a similar birth-cohort design in British Columbia to ours. A retrospective cohort study of birth records in California included more severely impaired CP cases eligible for the California Department of Developmental Services (Table I).²⁰ Medicaid data include milder cases (i.e. cases that only receive outpatient services). Our study is the first in the USA to combine disability service and claims data for trend analyses using a birth-cohort rather than cross-sectional design (Table I). Researchers in Norway used a similar approach which combined multiple data sources, but also included case review to obtain an accurate estimate of the CP prevalence.²¹ Quantifying the contribution of each administrative source to capture CP cases, we designed a population-based birth-cohort study in South Carolina, and assessed CP cases as well as all mortality in a prompt manner by not including case review methods.

METHOD

Study design and participants

We designed a population-based record linkage birth cohort study to ascertain all CP cases in live births that were tracked until at least 4 years of age⁹ among a 14-year birth cohort born from 1996 to 2009 in South Carolina. South Carolina does not have a CP registry. A transdisciplinary team including epidemiologists, neonatologists, and neurologists secured federal seed funding for the primary study on birth settings and neonatal seizures,²² while we conducted this pilot and quick assessment on CP. We included five statewide administrative data files: (1) birth certificates from the Department of Health and Environmental Control; (2) death certificates from the Department of Health and Environmental Control; (3) hospital discharge abstracts for inpatient and emergency room visits; (4) Medicaid services for both inpatient and outpatient visits; and (5) Department of Disabilities and Special Needs data. The South Carolina Revenue and Fiscal Affairs Office, a state data warehouse, linked these data sets, and removed identifiers. Based on match score of 90 or greater or more ‘fuzzy’ matches, each unduplicated person is assigned a random number and the unique ID generated by a computer program algorithm including social security number, first name, middle initial, last name, date of birth, ethnic group, and sex. This project was granted exempt status by the Medical University of South Carolina Institutional Review Board.

Numerator data and case definition

A CP case was operationalized as a child born in South Carolina to a mother who resided in South Carolina at the time of delivery, from 1996 to 2009 and who had a documented diagnosis code of CP during the first 4 years of life.⁹ We counted the child as a confirmed CP case if the diagnosis was noted in hospital discharge abstracts in at least one encounter or Medicaid files in at least two encounters, as has been done in Medicaid claims studies,²³

using search terms from the International Classification of Diseases, Ninth Revision (ICD-9), Clinical Modification codes 343.X.²³ Discharge files included primary and up to 14 secondary diagnoses; and Medicaid up to 8 secondary. For 531 children with only one CP encounter in Medicaid data within the first 4 years of life, we counted 157 cases with a second CP encounter from ages of 4 years to 10 years. The Department of Disabilities and Special Needs data file provided a CP diagnosis indicator for those meeting more stringent disability requirements (i.e. based on functional deficits and on-site assessment). The numerators in the prevalence rate were the sum of CP cases from these three sources. No minimum age of survival^{9,10} was required for case inclusion. Among 755 433 live births, we identified 2080 children (Fig. 1) with a CP diagnosis from linked records from Medicaid (1952 cases, 93%), Department of Disabilities and Special Needs (452 cases, 22%), and hospital discharge abstracts (768 cases, 37%). Each source contributed 1061 (51%), 57 (3%), and 64 (3%) unique cases respectively, after excluding 898 cases identified from more than one source. We did not exclude children with progressive neurological disorders.¹⁷

Denominator data in cerebral palsy measures

To estimate the annual prevalence of CP, we used the number of live births each year as the denominator. Other denominators included VLBW live births, VLBW neonatal survivors, and VLBW 1-year survivors. One-year survivors, defined as born alive and surviving the first birthday, were determined by subtracting the number of infant deaths from the number of live births.¹⁴ Neonatal survivors, defined as born alive and surviving the first 28 days, were determined by subtracting the number of neonatal deaths from the number of live births.

Birthweight strata included VLBW (<1500g), 1500g to 2499g, and 2500g or higher. Low birthweight is defined as under 2500g. Gestational age was extracted from birth certificates, routinely determined by last menstrual period or clinical estimate, and was stratified as 20 weeks to 27 weeks,⁵ 28 weeks to 31 weeks, 32 weeks to 36 weeks, and 37 weeks to 44 weeks.

Statistical analysis and evaluation

Descriptive statistics were computed and χ^2 tests were used to compare the CP prevalence estimates by maternal ethnic group and child's sex. Negative binominal regression was used to examine the trends over time and to compute the average annual change (AAC), stratified by birthweight, gestational week, sex, and maternal ethnic group. Spline regression techniques with smoothing effect were used to plot the trend in the Gplot procedure in SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) and to construct 95 percent confidence limits. Smoothing²⁴ resulted in narrower confidence limits and dampened the effect of marked variances among data points for visual display of trend lines.

RESULTS

Live births in South Carolina increased from a low of 48 622 (1996) to a high of 59 677 (2008). CP cases decreased from a high of 178 (1998) to a low of 122 (2006). The CP prevalence rate across all surveillance years was 2.8 per 1000 live births and showed

significantly downward trends, ranging from 3.6 per 1000 (1996) to 2.1 per 1000 (2006) (AAC of -3.0% [-4.4 to -1.6], $p<0.001$) (Fig. 2a).

Approximately, 3.7 percent (76) of the 2080 identified cases died before age 4 years; the frequency was 15.8 percent, 34.2 percent, 30.3 percent, and 19.7 percent at less than 1 year, 1 year, 2 years, and 3 year age groups (Table II). The overall prevalence was 2.7 per 1000 live births when excluding cases who died before age 4.

Downward prevalence was also consistent and significant across birthweight strata. The CP prevalence was 1.6 per 1000 live births 2500g or higher (Table III), ranging from 2.2 per 1000 (1996) to 1.2 per 1000 (2005, 2006, and 2008) (AAC of -3.3% [-5.1 to -1.6], $p<0.001$), and 7.0 per 1000 live births in 1500g to 2499g, ranging from 9.6 per 1000 (2000) to 3.6 per 1000 (2002) (AAC of -3.3% [-5.7 to -0.9], $p<0.01$).

Overall, the CP rate was 13.9 per 1000 low birthweight live births. CP prevalence was much higher in VLBW births, but decreased over time, as well. Means for the entire time period were: 46.0 per 1000 VLBW live births (Table III), ranging from 63.4 (1998) to 28.5 (2006) (AAC: -2.9% [-5.2 to -0.06], $p=0.01$); 46.2 per 1000 for VLBW neonatal survivors, ranging from 59.9 (1998) to 28.5 (2006) (AAC: -2.9% [-5.2 to -0.6], $p=0.01$); and 53.0 per 1000 for VLBW 1-year survivors, ranging from 69.3 (1998) to 33.2 (2006) (AAC: -2.6% [-4.8 to -0.5], $p=0.02$) (Fig. 2b).

CP prevalence per live births decreased significantly over time in all gestational age-specific groups and decreased as gestational age increased (AAC: -3.3% [-4.5 to -2.0], $p<0.01$), 65.5 per 1000 at 20 weeks to 27 weeks, ranging from 91.4 (2000) to 46.4 (2006); 32.2 per 1000 live births at 28 weeks to 31 weeks, ranging from 60.3 (1998) to 10.1 (2006) (Fig. 2c); 5.4 per 1000 live births at 32 weeks to 36 weeks, ranging from 8.4 (1996) to 3.1 (2008); and 1.6 per 1000 live births at 37 weeks to 44 weeks, ranging from 2.1 (1996, 1997) to 1.0 (2005).

Significant reductions over time in CP prevalence in non-Hispanic white infants (AAC: -2.2% [-4.0 to -3.2], $p=0.02$) and non-Hispanic black infants (AAC: -3.6% [-5.3 , -1.8], $p<0.001$) were confirmed, but CP prevalence (2.0/1000 live births) was low and stable for Hispanic infants (AAC: 0.06% [-5.6 to 5.7], $p=0.98$). CP prevalence among non-Hispanic black infants (3.7/1000) was significantly higher than among non-Hispanic white infants (2.3/1000) (prevalence ratio 1.60, 95% confidence interval [CI]: 1.46–1.75; $p<0.001$).

There were significant reductions in CP trends in both sexes: male: 3.1 cases per 1000 live births, ranging from 4.6 per 1000 (1996) to 2.4 per 1000 (2006) (AAC of -3.8% [-5.2 to -2.4], $p<0.001$); female: 2.4 cases per 1000, ranging from 2.9 per 1000 (1997) to 1.8 per 1000 (2006) (AAC of -2.0% [-3.8 to -0.1], $p=0.035$). However, overall CP prevalence among male infants was significantly higher than among female infants (prevalence ratio=1.30, 95% CI: 1.19–1.42; $p<0.001$) over 14 years, except for 1999 and 2007.

DISCUSSION

Using five statewide administrative data sets, we reported a CP prevalence of 2.8 per 1000 live births, 46.0 per 1000 VLBW live births, 53.0 per 1000 VLBW 1-year survivors, and 65.5 per 1000 live births at 20 weeks to 27 weeks' gestation in South Carolina from 1996 to 2009. We observed significant downward cohort trends across birthweight, gestational week, ethnic group, and sex strata. Unlike the non-reduction of CP prevalence in the Metropolitan Atlanta study which used a cross-sectional design and retrospective record review of CP and birthweights among 8-year-old children from 1985 to 2002,¹⁵ our record linkage birth-cohort study used Medicaid claims, hospital discharge files, and disability service data with measures from care providers. It assessed each child until at least 4 years of age to capture CP cases, but also included patients who died before 4 years of age. CP prevalence was higher among VLBW infants compared to normal birthweight infants, non-Hispanic black infants compared to non-Hispanic white infants, and males compared to female infants. Trends in CP prevalence in Hispanic infants did not change significantly.

Our findings of downward trends in CP prevalence in South Carolina differed from those in Atlanta,¹⁵ but were consistent with most findings from other countries.²⁵ Surveillance of Cerebral Palsy in Europe reported a falling prevalence of 60.6 to 39.5 per 1000 VLBW infants in 16 registers between 1980 and 1996,²⁵ from 70.9 to 35.9 per 1000 VLBW live births in 20 registers from 1980 to 2003,⁶ yet a stable prevalence among those of 2500g or higher between 1980 and 1998.⁸ The prevalence of 2.8 per 1000 live births in South Carolina included both presumed mild cases in Medicaid as well as early deaths of patients with CP in the numerator in order to include the widest base of CP cases possible. Our methods allowed us to capture a broader and more complete spectrum of CP cases compared to cases captured in California^{20,26} or survivors in Atlanta.¹⁴ The 53.0 per 1000 VLBW 1-year survivors rate of CP in South Carolina was lower than 65.2 to 58.6 per 1000 VLBW 1-year survivors in Atlanta¹⁴ and higher than 36 per 1000 VLBW infant survivors in two available neonatal intensive care units in North Carolina in 1994.¹³

CP trends may vary because of population compositions, sampling framework, services delivered, case definition, age at diagnosis, and the inclusion of early deaths among cases.^{2,3} The Healthy People 2020 target is to reduce the percentage of 8-year-old children with CP who were born at low birthweight from 50 percent to 45 percent.²⁷ Our finding of 13.9 per 1000 low birthweight live births was for cases up to 4 years of age, included early deaths among cases, and identified a broader spectrum of severity. Our indicator may be a useful alternative to link with perinatal practice to the Healthy People 2020 measure which will be harder to investigate and track. Limited studies and consensus are available on the minimum age of survival required for inclusion as a case or how to classify early CP deaths.^{9,10} In a study in British Columbia, 12 cases (2.4%) died before the 10th birthday.¹⁷

About 35 percent of severe CP died by age of 4 years in the United Kingdom Mersey CP Register.²⁸ In our South Carolina study, 3.7 percent of CP cases died before the 4th birthday; and excluding them changed the prevalence rate from 2.8 to 2.7 per 1000 live births. Death cases in patients with CP in birth cohorts in South Carolina demand further validation of CP diagnosis and survival status and comparative evaluation.

Created as a retrospective record review using a cross-sectional method,²⁹ the Centers for Disease Control and Prevention approach required intensive resources and thus has not been implemented widely;³⁰ nor did it assess yearly trends promptly in births after 2002. In contrast, our birth-cohort approach tracked all live births including early deaths up to age 4 years annually through 2009 in South Carolina, 7 years more current than the 2002 data from Atlanta.^{15,30} Standardized methods and well-designed studies (e.g. interrupted time series analysis) can better compare trends across time and states, monitor the burden of CP, and have the potential to assess the effects of etiological factors, service needs, mortality trends, and/or preventive services on CP rates over time.

This study has several limitations. First, the generalizability of our findings in South Carolina to other states is possibly limited because of differences in population compositions, environmental exposures, and clinical practices across states. Second, data quality and linkage in the administrative sources was not evaluated or monitored. There is uncertainty about misclassification bias, multiple entries from varying sources, and financial incentives that may affect coding practices, which warrant confirmation in future research, especially counting unduplicated early deaths. Medicaid data might miss prescribed, unused, or non-reimbursed services and only capture care provided in which a bill was submitted. Third, the use of administrative data sources did not allow us to capture CP cases that were acquired postnatally or had delayed first diagnosis after the 4th birthday; and we did not exclude 'outgrew' milder forms of CP.³¹ Fourth, we could not study CP severity or subtype, as the ICD-9 codes representing the subtypes varied in the same patient across encounters, providers, or sites.

To promptly monitor state-level CP trends, future studies need to set-up CP surveillance systems and validate our study methods: (1) can we validate CP diagnostic ascertainment in administrative data sources compared to medical record reviews? and (2) can administrative data capture the full spectrum of CP (i.e. validity of selection)? Administrative claims data in Quebec did not capture the full spectrum of CP.³² In the Centers for Disease Control and Prevention methods, 85 percent of all ascertained CP cases were found through education records.¹² In our study, 57 CP cases exclusively identified in Department of Disabilities and Special Needs data might come from referral sources not identified in Medicaid or Hospital Discharge data sets (e.g. the 0–3 early intervention program, private insurance). As a significant new source, Medicaid claims captured 51 percent of unique cases, including those from low-income households. Since 1984 South Carolina has included the Tax Equity and Fiscal Responsibility Act/Katie Beckett program to confer eligibility for CP children into the Medicaid program based on the income/resources of the child regardless of household income.³³ Thus, our CP cases should be more representative of families with a wide range of income levels, (i.e. not just cases from low-income families). Eighteen other states with the Katie Beckett program might be good places to validate our methods.

Utilizing administrative data sources in South Carolina, we captured CP cases identified up to 4 years of age and reported significant downward trends in CP prevalence in all live births and various subgroups such as VLBW 1-year survivors. Our data included 3.7 per cent of cases who died early and may represent a unique group not well captured or studied using other methods. We also disclosed disparities across birthweight, gestational weeks, sex, and

maternal ethnic group from 1996 to 2009. The potential benefits of this approach are that it is less cost-intensive than directly investigating individual patient records, and these administrative data sets can be queried in a timely fashion. We identified the need to further validate and advance our methods. Disability-free survival and number that suffer from neurodevelopmental outcomes were proposed as outcome measures for neonatal intensive care.³⁴ Our methods can serve as a stepping stone to establish public health surveillance systems, to rapidly evaluate clinical practice changes, and to inform etiological research of perinatal brain injury across mothers and infants. If used by researchers or government healthcare advisors for different diseases (e.g. asthma), populations, and countries, these epidemiologic methods may be explored in the CP international collaboration¹⁰ and provide a larger context for dialogue and efforts to overcome barriers that exist toward the identification and reductions in disability and costs, including poor interinstitution collaboration and decentralized systems in the USA.¹¹

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ABBREVIATIONS

AAC	Average annual change
VLBW	Very-low-birthweight

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What this paper adds:

- Birth-cohort cerebral palsy (CP) prevalence decreased in South Carolina from 1996 to 2009.
- CP prevalence was higher in very-low-birthweight infants, non-Hispanic blacks, and males.
- Three administrative data sets captured 2080 patients with CP in South Carolina.
- Medicaid claims contributed 51% of unique CP cases to the cohort.
- CP diagnoses included 76 patients who died before age 4 years.

Figure 1:

Three sources and counts of unique and overlapping cases with a cerebral palsy diagnosis in 2080 identified patients up to age 4 years in South Carolina, 1996 to 2009

Figure 2:

Prevalence of cerebral palsy (CP) before age 4 years by birthweight and gestational weeks in South Carolina, 1996 to 2009. (a) All live births. (b) Infants of birthweight less than 1500g.

(c) Infants at 20 weeks to 27 weeks and 28 weeks to 31 weeks. VLBW, very-low-birthweight.

A. Trends of cerebral palsy prevalence in live births in SC

B. Cerebral palsy prevalence among infants of birthweight <1,500 g in SC

C. Cerebral palsy prevalence by 20-27 and 28-31 weeks of gestation in SC

Characteristics of cerebral palsy surveillance programs or population-based studies in the USA

Table 1:

Study name or site reference	Birth years	Trend and/or prevalence	Source of CP diagnosis	Approximate number of denominator per year	Minimum age of survival for inclusion (y)	Postneonatal brain injury age limit (y)
Metropolitan Atlanta Developmental Disabilities Surveillance Program (Atlanta) ¹⁴	1975–1977, 1981–1985, 1986–1991	Upward trend from 1.7 to 2.0 per 1000 1-year survivors, stable from 65.2 to 58.6 per 1000 VLBW 1-year survivors	Record review at school, hospitals, clinics, et al.	45 000–50 000 children age 8y residing in area	8	8
The Autism and Developmental Disabilities Monitoring Network (Atlanta) ¹⁵	1985–2002	Stable from 1.9 to 1.8 cases per 1000 1-year survivors in the spastic CP subgroup	Record review at school, hospitals, clinics, et al.	130 000–150 000 children age 8y residing in area	8	8
The Autism and Developmental Disabilities Monitoring Network (Atlanta) ¹⁶	1998–2002	Downward from 3.5 to 2.9 cases per 1000 among 8-year-old children	Record review at school, hospitals, clinics, et al.	125 166–130 884 live births residing in area	8	8
Northwest North Carolina, two neonatal intensive care units ¹³	1982–1986 1986–1990 1990–1994	Downward trend, 11.3% to 5.2% VLBW 1-year survivors, 36 per 1000 VLBW infant survivors	Multidisciplinary evaluation and physical therapists confirmed	1282 infant survivors, birthweights of 500 to 1500g	1	
Four San Francisco Bay area counties, California ²⁶	1983–1985	1.4 severe CP cases per 1000 live births	DDS, Disability service standardized exam, or record review	Could not find	3	
CP Research Registry (Chicago) ^{10,11}	Enrolled 2006		Parental report	3 941 000 live births	No	5
Weinberg Family CP Centre (New York) Columbia CP Registry ¹⁰	1977		Provider report	239 200 live births	No	No
California ²⁰	1991–2001	Serious disability, 1.2 per 1000 survivors, not used for prevalence	DDS, eligibility confirmed by physicians	6 221 001 births, 565 546 per year	5	
South Carolina Birth Cohort CP Project in this paper	1996–2009	Downward trend from 3.6 to 2.1 per 1000 live births, 53.0 per 1000 VLBW 1-year survivors	Provider report in Medicaid, hospital discharge, DDSN	48 622 to 59 677 live births per year	No	No

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CP, cerebral palsy; VLBW, very low birthweight; DDS, California Department of Developmental Services; DDSN, South Carolina Department of Disabilities and Special Needs.

Table II:

The counts and proportion of early deaths at each age group in the 2080 identified patients with cerebral palsy before age 4 years in South Carolina, 1996 to 2009

Age at death (y)	Count	Cumulative % 76 deaths	Cumulative count	Cumulative % 2080 cases
<1	12	15.8	12	0.6
1	26	34.2	38	1.3
2	23	30.3	61	1.1
3	15	19.7	76	0.7
Sum	76	100.0	76	3.7

Table III:

Means and ranges of cerebral palsy prevalence in 14 years across birthweight strata in South Carolina, 1996 to 2009

Birthweight strata	Mean value	Highest value	Lowest value
Overall cohort ^a	2.8	3.6	2.1
2500g ^a	1.6	2.2	1.2
<2500g ^a	13.9	19.1	10.1
1500-2499g ^a	7.0	9.6	3.6
<1500g per 1000			
Live births	46.0	63.4	28.5
Neonatal survivors	46.2	59.9	28.5
1-year survivors	53.0	69.3	33.2

^aPer 1000 live births. Cerebral palsy prevalence is number of cases of cerebral palsy by age 4 years divided by number of live births.