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Educational Disabilities Among Children Born With Neonatal Abstinence Syndrome

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Abstract

BACKGROUND: Neonatal abstinence syndrome (NAS) is a postnatal drug withdrawal syndrome that can occur after intrauterine opioid exposure. Adverse neurobehavioral outcomes have been documented in infants with NAS; however, educational outcomes have not been thoroughly examined. We analyzed Tennessee data to understand the need for special educational services among infants who are born with NAS.

METHODS: By using Tennessee Medicaid and birth certificate data, infants who were born in Tennessee between 2008 and 2011 with a history of NAS were matched (1:3) to infants who were born during the same period without a history of NAS. Groups were matched on the basis of sex, race and/or ethnicity, age, birth region of residence, and Medicaid enrollment status. Data were linked to Tennessee Department of Education special education data during early childhood (3–8 years of age). Conditional multivariable logistic regression was used to assess associations between NAS and selected special education outcomes.

RESULTS: A total of 1815 children with a history of NAS and 5441 children without NAS were assessed. Children with NAS were significantly more likely to be referred for a disability evaluation (351 of 1815 [19.3%] vs 745 of 5441 [13.7%]; $P < .0001$), to meet criteria for a disability (284 of 1815 [15.6%] vs 634 of 5441 [11.7%]; $P < .0001$), and to require classroom therapies or services (278 of 1815 [15.3%] vs 620 of 5441 [11.4%]; $P < .0001$). These findings

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were sustained in a multivariable analysis, with multiple models controlling for maternal tobacco use, maternal education status, birth weight, gestational age, and/or NICU admission.

CONCLUSIONS: Results of this novel analysis linking health and education data revealed that children with a history of NAS were significantly more likely to have a subsequent educational disability.

Neonatal abstinence syndrome (NAS) is a postnatal drug withdrawal syndrome that can occur after intrauterine opioid exposure. Common symptoms of NAS in newborns include tremors, high-pitched crying and irritability, poor feeding, vomiting and diarrhea, and temperature instability.[1] In conjunction with the ongoing opioid epidemic, NAS has become a growing problem in the United States and around the world.[2] During 2000–2012, the rate of NAS in the United States increased from 1.2 to 5.8 cases per 1000 hospital births per year[3,4]; by 2012, an infant was born with NAS approximately every 25 minutes.[4] In Tennessee, rates of NAS have increased >1700% since 1999 (from 0.7 to 13.0 cases per 1000 hospital births per year in 2015; Tennessee Hospital Discharge Data System, unpublished observations). Despite the increasing incidence of NAS worldwide, data regarding the long-term outcomes of intrauterine opioid exposure are limited and inconsistent.[5] Several studies have revealed that infants with intrauterine exposure to opioids might be at an increased risk for neurodevelopmental problems or adverse cognitive, psychomotor, and behavioral outcomes; however, the quantifiable impact on these children, their families, and society is less understood.[6,7]

The Tennessee Department of Health received anecdotal reports from educators in Tennessee that children with a history of NAS had greater learning challenges and behavioral difficulties in the classroom; therefore, we sought to better understand the possible associations between NAS and educational outcomes. Given the reports that we had received and the available data, we chose to focus on special education outcomes. In Tennessee, 16 conditions qualify as educational disabilities (autism, deaf-blindness, deafness, developmental delay, emotional disturbance, functional delay, hearing impairment, intellectually gifted, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, specific learning disabilities, speech or language impairment, traumatic brain disorder, and visual impairment). Children can be referred for evaluation of a possible educational disability beginning at 3 years of age; the referral can be initiated through early intervention services, the school system, a health care provider, or a parent. An assessment team determines if the child qualifies for an educational disability. Children who are eligible receive a written individualized education program that is specific to their needs, which might include special services, therapies, or accommodations (such as physical, occupational, or speech therapy), extra time or modified assignments. Early intervention services are the precursor to special education services for children <3 years of age. In Tennessee, NAS is an automatically qualifying diagnosis for early intervention services but does not automatically qualify children for special education services. To better understand the associations between NAS and educational outcomes, 3 primary special education outcome measures were assessed: (1) referral for evaluation of a possible educational disability, (2) results of the eligibility determination, and (3) receipt of therapies or services.

METHODS

We used data from Tennessee's health and education administrative databases for children who were born in Tennessee between 2008 and 2011. Children with a history of NAS during their birth hospitalization (as defined by the *International Classification of Diseases, Ninth Revision* code [779.5: drug withdrawal syndrome in newborn]) who were born between 2008 and 2011 were identified from Tennessee Medicaid (TennCare) insurance claims data. After cases were identified, they were assigned to matching strata on the basis of sex, race and/or ethnicity, TennCare enrollment status, age, and region of residence. Next, each case was frequency matched to 3 children in the comparison group from Tennessee vital records (birth certificate) data from 2008 to 2011 within the same matching strata.[8] Previous studies have revealed differences in the prevalence of developmental disabilities related to sex, race and/or ethnicity, and socioeconomic status[9-12]; therefore, the groups were matched by sex, race and/or ethnicity, and TennCare enrollment status. TennCare enrollment status was used as a proxy for socioeconomic status; children born to women who are eligible for Medicaid are automatically eligible for 1 year after birth. Pregnant women are eligible for TennCare if their annual (yearly) income is ≤195% of the federal poverty level.[13] To ensure a comparison of children of similar ages, the groups were matched by age. Finally, because of regional variation in school systems, the groups were matched by region of residence at birth. Identifiers from the matched data set were provided to the Tennessee Department of Education for linkage (first name, last name, and date of birth) to special education data through November 2016 (Fig 1). Because children in our analysis were born between 2008 and 2011, they were 3 to 8 years of age at the time of the linkage to educational data. A limited number of researchers had access to identified data for the data linkage, and a deidentified data set was used for analysis. Children were excluded from this analysis if their educational disability was "intellectually gifted." Statistical analyses were performed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC). Pearson's χ^2 test was used for descriptive comparisons between groups, and a conditional multivariable logistic regression was used to examine the associations between a history of NAS and outcomes of interest. In addition to controlling for the matching factors, the regression model controlled for maternal education status as a proxy for socioeconomic status and because previous studies have revealed that lower maternal education is associated with a higher prevalence of developmental disabilities,[9-12,14] as well as for maternal tobacco use during pregnancy, because this increases the risk of NAS development.[15] Additional models were constructed, controlling for the aforementioned factors, low birth weight, preterm birth, or NICU admission. Adverse neonatal outcomes, such as low birth weight, preterm birth, and NICU admission, are associated with NAS and have been reported as independent predictors of poor educational outcomes.[9-12,14,15] As such, we hypothesize that they are likely part of the causal pathway for the development of educational disabilities. All P values were 2-sided and were considered statistically significant if $P < .05$. This study was approved by the Tennessee Department of Health Institutional Review Board and determined to be an evaluation or a control of a public health problem by the Centers for Disease Control and Prevention.

RESULTS

Demographic Information

A total of 1815 children with a history of NAS and 5441 children without a history of NAS were analyzed. Four children (all without a history of NAS) were excluded from this analysis because of an educational disability of "intellectually gifted." Matching led to a balanced data set with no significant differences found between children with a history of NAS and children without a history of NAS regarding sex, race and/or ethnicity, age, region of residence, and TennCare enrollment status. However, children with a history of NAS were significantly more likely to be born with a low birth weight (<2500 g [24.0% vs 9.2%; $P < .0001$]), to be born preterm (<37 weeks' gestation [21.6% vs 11.5%; $P < .0001$]), and more likely to have been admitted to the NICU (20.9% vs 5.8%; $P < .0001$; Table 1). Mothers of children with NAS were also less likely to have received prenatal care during their pregnancy (92.4% vs 98.3%; $P < .0001$), and those who did receive prenatal care had fewer prenatal care visits (mean: 9.4 [range: 0–30] vs mean: 11.8 [range: 0–40]; $P < .0001$; Table 1).

Special Education Outcomes

Of 1815 children with a history of NAS, 351 (19.3%) were referred for evaluation of a possible educational disability, a significantly higher proportion than among children without a history of NAS (13.7%; $P < .0001$; Table 2). Approximately 15% of children with a history of NAS met criteria for a qualifying educational disability and were eligible for services, compared with 11.6% ($P < .001$) of children without a history of NAS. Five of the 16 possible qualifying educational disabilities in Tennessee accounted for >95% of the educational disabilities that were identified among children in our analysis, and a significantly higher proportion of children with a history of NAS were diagnosed with educational disabilities of developmental delay (5.3% vs 3.5%; $P = .001$) and speech or language impairment (10.3% vs 8.3%; $P = .009$). Lastly, 15.3% of children with a history of NAS received therapies or services, compared with 11.4% of children without a history of NAS. Children with a history of NAS were significantly more likely to receive classroom or testing accommodations (5.4% vs 4.1%; $P = .02$) or speech therapy (14.0% vs 10.8%; $P = .0002$) than children without a history of NAS.

A conditional multivariable logistic regression was conducted to assess the associations observed during the univariate analysis (Table 3). Children with a history of NAS had significantly higher odds of being referred for evaluation of a possible educational disability (adjusted odds ratio [aOR]: 1.44; 95% confidence interval [CI]: 1.23–1.67), qualifying for an educational disability (aOR: 1.36; 95% CI: 1.15–1.60), and receiving therapies or services (aOR: 1.37; 95% CI: 1.16–1.61). Consistent with the univariate analysis, the odds of a diagnosis of developmental delay (aOR: 1.34; 95% CI: 1.03–1.76) and speech or language impairment (aOR: 1.26; 95% CI: 1.04–1.52) were higher for children with a history of NAS. In addition, a regression analysis confirmed that the odds of receiving accommodations (aOR: 1.32; 95% CI: 1.03–1.69) or speech therapy (aOR: 1.33; 95% CI: 1.12–1.57) were higher in children with a history of NAS. Multiple variations of the original regression model were created to assess the potential effects of controlling for birth weight, gestational age, or NICU admission (Table 4). In all models, the significant findings for all 3 primary special education outcome measures were sustained in a multivariable analysis.

A post hoc subanalysis was conducted to understand the educational disability referral pathway. Of those children who were referred for evaluation of a possible disability, 80.9% (284 of 351) of children with a history of NAS and 85.1% (634 of 745) of children without a history of NAS qualified for an educational disability and were eligible for services ($P = .08$). Among children who were eligible for services, 97.9% of children with a history of NAS (278 of 284) and 97.8% of children without a history of NAS (620 of 634) received therapies or services ($P = .93$).

DISCUSSION

We performed a novel analysis by linking health and education data sets to examine special education outcomes of children with a history of NAS in the United States. Our results revealed that children with a history of NAS were more likely to be referred for evaluation of an educational disability, to meet criteria for an educational disability, and to receive special education therapies or services. Special education disabilities of developmental delay and speech or language impairment were more likely to be diagnosed among children with a history of NAS, and accommodations or speech therapy services were more likely to be received. Our analysis indicates that children with a history of NAS are more likely to require special education services, therefore reinforcing efforts that are focused on reducing intrauterine opioid exposure and NAS.

In a recent analysis conducted by Oei et al[16] in Australia, the authors examined school performance outcomes of children with NAS by comparing mean standardized test scores among children with a history of NAS, a control group (matched on sex, gestational age, and socioeconomic status), and the rest of the birth cohort in New South Wales. Results revealed that a diagnosis of NAS was associated with poor and deteriorating performance on academic tests from as early as 8 years of age. In addition, children with a history of NAS in grade 7 scored lower on standardized tests than children in grade 5 who were an average of 2 years younger. In our analysis, we evaluated different educational outcomes and add to the body of evidence that children with a history of NAS can face educational challenges in early childhood and beyond.

Despite this growing body of evidence, the etiology of possible educational disabilities in children with a history of NAS is not well understood; however, we are learning more about the impact opioids can have on the human brain. Recent longitudinal studies have revealed gray matter volume loss among adults on chronic opioid therapy within 1 month of therapy initiation.[17,18] Studies have also indicated that brain volumes of infants and school-aged children with exposure to opioids might be smaller than expected, especially in the basal ganglia, an area of the brain that is associated with voluntary movement, procedural learning, cognition, and emotion.[19,20] Animal models have provided evidence that additional neurologic effects from prenatal opioid exposure occur, including structural modifications and the disruption of neurotransmitter systems.[21,22] In a recent study by Monnelly et al,[23] the authors compared diffusion MRI results in 20 term neonates with exposure to methadone with those in 20 controls without exposure to methadone and identified a microstructural alteration in the major white matter tracks, which was present at birth. Although further study is needed to better understand the underlying mechanisms for these neurologic changes and their quantifiable effects, much of the current evidence reveals consistent findings.

In addition to these biological and developmental factors, children with a history of NAS are often raised in difficult social and economic environments. Parental substance abuse can be a traumatic event in a child's life, and children who are raised in environments that are affected by addiction might have more cognitive impairments.[24] Although a child's environment undoubtedly has an impact on their development and cognition, other studies indicate that the environment might not be the sole cause for cognitive or behavioral challenges observed in children with a history of NAS. One such study revealed that, even when controlling for socioeconomic status, gestational age, and birth weight, children with prenatal exposure to opioids or other substances who were fostered or adopted had lower cognitive abilities than the control group. These findings persisted into school age and indicate that children with prenatal exposure to opioids can be at risk even when living in low-risk, stable environments.[25]

There is a risk of development of NAS for any infant who is exposed to opioids in utero, whether through prescription medications (obtained legally or through diversion), illicit drugs, or opioid-agonist medication–assisted treatment. The scope of our analyses did not facilitate further stratification to assess our outcome of interest (educational disability) related to the source of maternal opioid exposures. Future studies may facilitate the assessment of maternal opioid sources or clinical approaches to opioid abuse in pregnant mothers and various impacts on infants. Although medication-assisted treatment can be associated with NAS, pregnant women who undergo treatment of opioid use disorder with medication-assisted treatment can make plans to deliver at a health care facility that is prepared to monitor, evaluate for, and treat NAS, if needed.[26-28]

Lack of educational success places children at a higher risk for mental and physical illness, substance abuse, unemployment, and other adverse outcomes later in life.[16,29] Individual and population-level data reveal that poor academic performance can undermine occupational and educational trajectories into adulthood as well as mortality, marriage, and unemployment rates.[29] Considerable resources are available to infants and children who might be at risk for developmental delay or disability through developments in the Individuals with Disabilities Education Act. This federal legislation ensures that students (3–21 years of age) with a disability are provided a free, appropriate, and public education through special education services and provides assessments and early intervention services to children with disabilities as early as birth to 2 years of age.[30] Enrollment in early intervention and special education programs positively affects developmental outcomes, and participating children have demonstrated better than expected development in different domains.[30-35] Benefits from these services, including improved educational outcomes, appear to extend into adulthood; however, not all children who are eligible for early intervention and special education services are receiving them.[36-38]

In Tennessee, NAS is an automatically qualifying diagnosis for early intervention services.[39] Early intervention services are the precursor to special education services for children <3 years of age; however, the proportion of all children with a history of NAS who undergo evaluation for early intervention is unclear. Preliminary data from Tennessee Early Intervention Services revealed that ~5% (96 of 1815) of the children with NAS who were included in our analysis were referred to early intervention services with a primary diagnosis of NAS, and only ~10% (10 of 96) of that group went on to be referred for special education services (Tennessee Early Intervention Services, unpublished observations). Our analysis indicates that children with a history of NAS are developmentally vulnerable and more likely to have educational disabilities in early childhood. Appropriate referrals for evaluation of needs for early intervention or special education services (with the first evaluation occurring before school age) are critical. In our analysis, we found a high specificity for referral for evaluation of a possible educational disability: >80% of children with and without a history of NAS who were referred were also qualified for an educational disability, and 98% of both groups who were eligible for services received them.

The most common educational disabilities among our study population were developmental delay and speech or language impairment. Because children in our analysis were born between 2008 and 2011, they were 3 to 8 years of age at the time that educational data were obtained. Diagnoses of developmental delay and speech or language impairment can be applied broadly in younger-aged children to encompass other more precise syndromes (autism spectrum disorder, intellectual disability, and learning disability), which can be diagnosed when a child is older. This reinforces the need for both early and ongoing evaluation of children at a high risk of educational disabilities. Increased awareness of available services and the importance of early referral from families and caregivers as well as health care providers, case managers, social workers, and other key stakeholders are vital to improving referral rates and outcomes for this vulnerable population. However, school systems in areas with high rates of NAS might also have a greater demand for therapies and services.

Our analysis has several limitations. We were unable to analyze all children who were born with NAS in Tennessee between 2008 and 2011; however, best estimates are that TennCare provides services to ~90% of children who are born with NAS in Tennessee.[40] NAS can occur after fetal exposure to substances (benzodiazepines, selective serotonin reuptake inhibitors, and alcohol) other than opioids, and we were unable to validate that all children with NAS in our sample had in utero opioid exposure or confirm that children without NAS did not have in utero opioid exposure.[1] In addition, matching to Tennessee's special education database on selected identifiers might have failed to match some children who had been referred. Matching inaccuracies may have a differential impact on children with a history of NAS. Furthermore, because NAS is an automatically qualifying diagnosis for early intervention services in Tennessee, there may be differential referral patterns into the special education system for children with a history of NAS compared with those children without a history of NAS. However, because preliminary data from Tennessee Early Intervention Services revealed that only ~5% of the children with NAS in our analysis were referred to early intervention services, we believe that it is unlikely that these potential differential referral patterns had a significant effect on our results. We were also unable to control for some factors in the logistic regression that have been revealed in previous studies to increase the risk of NAS.[14] Finally, we were unable to verify the diagnostic coding of NAS or stratify our results on the basis of NAS severity; therefore, some children in our analysis might have had iatrogenic withdrawal or mild withdrawal symptoms.

We performed a novel analysis by linking health and education data sets and demonstrated that children with a history of NAS were significantly more likely to be referred for evaluation of an educational disability, to meet criteria for an educational disability, and to receive therapies or services for educational disabilities. Furthermore, children with a history of NAS were more likely to be diagnosed with educational disabilities of developmental delay and speech or language impairment. These results further substantiate the need for efforts to reduce intrauterine opioid exposure and NAS.

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ABBREVIATIONS

aOR	adjusted odds ratio
CI	confidence interval
NAS	neonatal abstinence syndrome
TennCare	Tennessee Medicaid

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WHAT'S KNOWN ON THIS SUBJECT: Infants with intrauterine opioid exposure might be at risk for adverse neurodevelopmental, cognitive, or behavioral outcomes. Australian data demonstrated that children with neonatal abstinence syndrome (NAS) have poor and deteriorating school performance; however, educational outcomes among American children with NAS have not been examined.

WHAT THIS STUDY ADDS: Children in Tennessee with a history of NAS were significantly more likely to be referred for evaluation of a possible educational disability, to meet criteria for an educational disability, and to receive school-based therapies or services for educational disabilities.

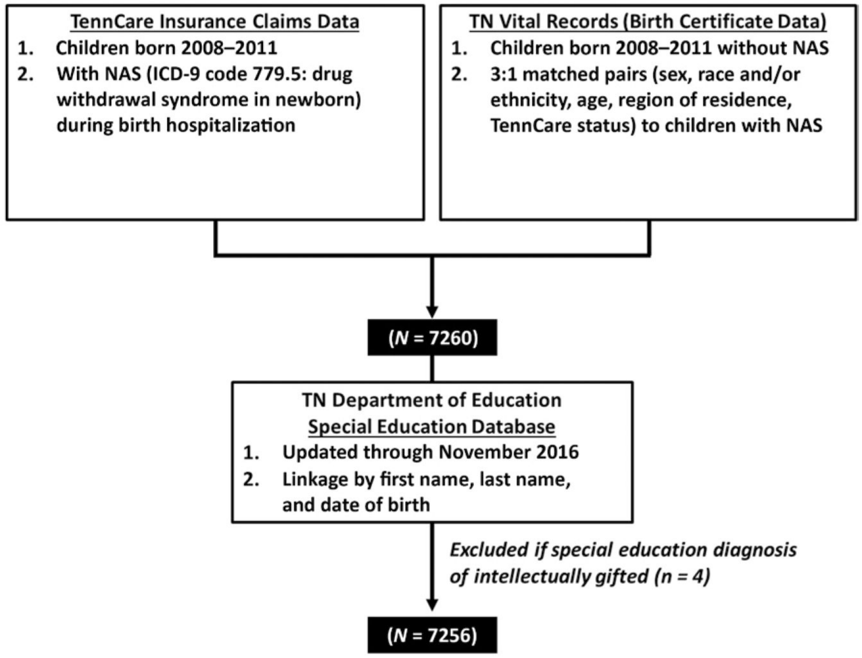

FIGURE 1.

Construction of the data set for analysis. ICD-9, *International Classification of Diseases, Ninth Revision*; TN, Tennessee.

TABLE 1

Delivery and Birth Characteristics of Children With a History of NAS (*N* = 1815) and Children Without a History of NAS (*N* = 5441)

Characteristic	With NAS	Without NAS	*P*
Birth weight <2500 g, *n* (%)	435 (24.0)	500 (9.2)	<.0001
Gestational age <37 wk, *n* (%)	392 (21.6)	625 (11.5)	<.0001
NICU admission, *n* (%)	379 (20.9)	315 (5.8)	<.0001
Maternal tobacco use during pregnancy, *n* (%)	1196 (65.9)	1640 (30.1)	<.0001
Mother unmarried, *n* (%)	1282 (70.6)	3258 (59.9)	<.0001
Maternal education less than high school degree, *n* (%)	611 (33.7)	1571 (28.9)	<.0001
Prenatal care, *n* (%)	1677 (92.4)	5351 (98.3)	<.0001
No. prenatal care visits, mean (range)	9.4 (0–30)	11.8 (0–40)	<.0001

TABLE 2

Univariate Analysis of Special Education Outcomes of Children With a History of NAS (*N* = 1815) and Children Without a History of NAS (*N* = 5441)

Outcome	With NAS, *n* (%)	Without NAS, *n* (%)	*P*
Referred for evaluation	351 (19.3)	745 (13.7)	<.0001
Eligible for services	284 (15.6)	634 (11.6)	<.0001
Autism	6 (0.3)	22 (0.4)	.8
Developmental delay	96 (5.3)	193 (3.5)	.001
Other health impairment	12 (0.7)	27 (0.5)	.5
Specific learning disability	7 (0.4)	16 (0.3)	.6
Speech or language impairment	187 (10.3)	451 (8.3)	.009
Received therapies or services	278 (15.3)	620 (11.4)	<.0001
Accommodations	98 (5.4)	225 (4.1)	.02
Aide or paraprofessional	3 (0.2)	12 (0.2)	.2
Occupational	55 (3.0)	126 (2.3)	.09
Physical	17 (0.9)	54 (1.0)	.8
Speech	255 (14.0)	586 (10.8)	.0002

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TABLE 3

Conditional Multivariable Logistic Regression Used To Analyze Special Education Outcomes of Children With a History of NAS (N = 1815) and Children Without a History of NAS (N = 5441)

Outcome	aOR (95% CI)
Referred for evaluation	1.44 (1.23–1.67)
Eligible for services	1.36 (1.15–1.60)
Developmental delay	1.34 (1.03–1.76)
Speech or language impairment	1.26 (1.04–1.52)
Received therapies or services	1.37 (1.16–1.61)
Accommodations	1.32 (1.03–1.69)
Speech	1.33 (1.12–1.57)

Explanatory regression model was controlled for matching factors (sex, race and/or ethnicity, age, public health region of residence, TennCare insurance status), maternal tobacco use during pregnancy, and maternal education status.

TABLE 4

Various Conditional Multivariable Logistic Regression Models Used To Analyze Special Education Outcomes of Children With a History of NAS (N = 1815) and Children Without a History of NAS (N = 5441)

Outcome	aOR (95% CI)
Model 1[a]	
Referred for evaluation	1.44 (1.23–1.67)
Eligible for services	1.36 (1.15–1.60)
Received therapies or services	1.37 (1.16–1.61)
Model 2[b]	
Referred for evaluation	1.33 (1.14–1.56)
Eligible for services	1.27 (1.08–1.51)
Received therapies or services	1.28 (1.08–1.52)
Model 3[c]	
Referred for evaluation	1.41 (1.21–1.64)
Eligible for services	1.33 (1.13–1.57)
Received therapies or services	1.34 (1.14–1.59)
Model 4[d]	
Referred for evaluation	1.34 (1.14–1.56)
Eligible for services	1.28 (1.08–1.51)
Received therapies or services	1.28 (1.09–1.52)
Model 5[e]	
Referred for evaluation	1.32 (1.13–1.54)
Eligible for services	1.26 (1.06–1.49)
Received therapies or services	1.27 (1.07–1.50)

[a] Controlled for matching factors (sex, race and/or ethnicity, age, public health region of residence, TennCare insurance status), maternal tobacco use during pregnancy, and maternal education status.

[b] Controlled for matching factors, maternal tobacco use during pregnancy, maternal education status, and birth weight.

[c] Controlled for matching factors, maternal tobacco use during pregnancy, maternal education status, and gestational age.

[d] Controlled for matching factors, maternal tobacco use during pregnancy, maternal education status, gestational age, and birth weight.

[e] Controlled for matching factors, maternal tobacco use during pregnancy, maternal education status, gestational age, birth weight, and NICU admission.