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Behavioral Outcomes of Extremely Low Birth Weight Children at Age 8 Years

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Abstract

Objective—To describe the prevalence of behavioral problems and symptomatology suggestive of Autism and Asperger's disorders at age 8 years among extremely low birth weight (ELBW, <1 kg) children, born 1992 through 1995.

Method—Parent reports of the behavior of 219 ELBW (mean birth weight, 810 g; gestational age 26 weeks) were compared with 176 normal birth weight children of similar maternal sociodemographic status, sex, and age. Behavior was assessed via the Child Symptom Inventory that includes both Symptom Severity Scores and scores meeting DSM-IV criteria for disorders.

Results—ELBW compared with normal birth weight children had significantly higher mean Symptom Severity Scores for the inattentive, hyperactive, and combined types of attention-deficit hyperactivity disorder (all $p < .001$) as well as higher scores for Generalized Anxiety ($p < .01$) and Autistic ($p < .001$) and Asperger's ($p < .01$) disorders. When DSM-IV criteria were considered, ELBW children also had significantly higher rates of attention-deficit hyperactivity disorder of the inattentive (10% vs 3%, $p < .01$) and combined (5% vs 0.6%, $p < .05$) types.

Conclusions—Attention-deficit hyperactivity disorder, mainly the inattentive type is prevalent among ELBW children. Our findings of an increase in symptoms pertaining to Autistic and Asperger's disorders at school age agree with recent reports of others during early childhood. Early identification and intervention for these problems might improve child functioning and ameliorate parent and child distress.

Index terms

extremely low birth weight; attention deficit hyperactivity disorder; anxiety disorder; autism; Asperger's

The early 1990s were characterized by major therapeutic advances in perinatal care that resulted in an increase in survival of children of extremely low birth weight (<1 kg).[1] Unfortunately, these advances were accompanied by an increase in neonatal complications of prematurity and poorer neurodevelopmental outcomes during early childhood.[2] These sequelae were partly due to the survival of extremely sick and immature infants who

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previously would have died and also to iatrogenic complications resulting from neonatal therapies.[3]

Reports of behavioral problems of school-age children born during the first half of the 1990s, have, to date, pertained to extremely immature infants born at <26 weeks gestation in Britain and Sweden and to those born at <1 kg birth weight and/or <28 week-gestation infants in Australia. Reported problems have included inattention and hyperactivity, internalizing and thought problems and social and peer problems.[4–6] There have also recently been reports, based on screening assessments, that suggest that Autism may be prevalent among preterm children.[7–9] John-son et al[8,10] reported in an abstract that the British cohort of <26 weeks gestation had higher levels of the Autism Spectrum Disorder on the Social Communication Questionnaire compared with controls at age 11 years. Two studies in the United States found that 26% and 22% of <1.5 kg birth weight and <28 weeks gestation children, respectively screened positive on the Modified Checklist for Autism in Toddlers at around 2 years of age.[9,11]

The primary objective of this study was to describe the behavioral outcomes, including screening for symptomatology suggestive of Autism and Asperger's Disorders, in a cohort of 8-year-old extremely low birth weight children, born 1992 through 1995 in Cleveland, OH, as compared with a normal birth weight comparison group of children. The secondary objective was to examine sociodemographic (socioeconomic status) and neonatal correlates of behavioral differences identified between the extremely low birth weight children and normal birth weight children.

POPULATION AND METHODS

Extremely Low Birth Weight Cohort

The study population included 219 surviving 8-year-old extremely low birth weight (ELBW) children, 92% of the birth cohort, admitted to the neonatal intensive care unit at Rainbow Babies and Children's Hospital during the years 1992 through 1995. Children with major congenital malformations or intrauterine infections were excluded. A description of the birth cohort and early childhood outcomes has previously been reported.[12]

Comparison Group

A normal birth weight (NBW) child born at term gestation by parent report (>36 weeks), was selected at age 8 years by random selection of a child from the same school as the ELBW child who was within 3 months of age and of the same race and sex. Matches were selected for 176 ELBW children.[13]

Measures and Variables

Eight-Year Study Protocol—The primary outcome measure of behavior was the Parent Child Symptom Inventory (CSI-4) completed by the caregiver.[14] This was the biological or adoptive mother for 89% of both ELBW (195 of 219) and NBW (157 of 176) groups. Other respondents included 6 foster parents of ELBW children and extended family members for the other ELBW and NBW children. The CSI-4 is a self-administered questionnaire which screens for behavioral, emotional, and cognitive symptoms of DSM-IV defined disorders.[15] It takes 10 to 15 minutes to complete. The symptom categories include: attention-deficit hyperactivity disorder (ADHD) including the inattentive (9 items), hyperactive/impulsive (9 items), and combined types of ADHD (18 items); oppositional defiant disorder (8 items); conduct disorder (15 items); generalized anxiety disorder (8 items); social phobia (4 items); separation anxiety disorder (8 items); major depressive disorder (10 items); schizophrenia (5 items); and the pervasive developmental disorder (PDD) including the Autistic and

Asperger's disorders (12 items). The CSI-4 also contains single items which screen for specific phobias, obsessions, compulsions, vocal and motor tics, and posttraumatic stress disorder.

The results were scored in 2 ways: Symptom Severity and Symptom Count Scores. Symptom Severity Scores are the sum of item scores for a particular symptom category (i.e., within a set of items pertaining to a given behavior disorder). These include 0 (never), 1 (sometimes), 2 (often), and 3 (very often). Symptom Count Scores are the sum of symptoms rates as (often/very often) within each symptoms category. When the Symptom Count Score within a category equaled or exceeded the number of symptoms specified by DSM-4 (Symptom Criterion Score), the child was defined as having met the DSM-IV criterion for that disorder. The parent CSI-4 checklist is a reliable and valid screening instrument for emotional and behavioral disorders of children. It has excellent test-retest reliability and satisfactory predictive validity for a variety of childhood disorders in comparison with structured psychiatric interviews and databased psychiatric diagnoses. It has significant discriminant validity and a high degree of concurrent validity with corresponding dimensional behavioral rating scales such as the Child Behavior Checklist.[14,16,17] Scale reliabilities for our sample were high with Cronbach's alphas of 0.92 for inattentive ADHD, 0.88 for hyperactive ADHD, 0.93 for combined type of ADHD, and 0.76 for anxiety. Reliability was 0.82 for Autistic disorder and 0.71 for Asperger's disorder.

The symptoms that encompass the 3 primary characteristics of PDD include impairments in social interaction skills, verbal/language and nonverbal communication skills, and repetitive and stereotypical patterns of behavior. Table 1 presents the items included in the CSI-4, which were adapted from the DSM-IV criteria.[14,15] All 12 symptoms pertain to the Autistic disorder. For this disorder, there need to be a minimum of 6 of these 12 symptoms coded as "often" or "very often" with at least 2 symptoms from the social interaction category, and 1 each from the communication and repetitive stereotyped patterns of behavior categories. Developmental abnormalities must be apparent in at least one of the 3 areas before the age of 3 years. Asperger's disorder includes a lack of significant delay in communication/ language or cognitive development. Specifically, for Asperger's disorder at least 3 symptoms coded as "often" or "very often" with at least 2 symptoms of difficulties in social interaction and at least one symptom of repetitive and stereotyped behavior are required. Pervasive developmental disorder not otherwise specified is used for children who have pervasive impairment in the 3 primary characteristics of pervasive developmental disorder, described in Table 1, but who do not meet the criteria for the Autistic or Asperger's disorders. Agreement between the CSI-4 scores and the clinical diagnoses of the Autistic Disorder has revealed a sensitivity of 0.64 and a specificity of 0.99, indicating that the parent CSI-4 identifies a modest proportion of children with Autistic disorder but with minimal false positives.[14]

Additional measures included information pertaining to family sociodemographic descriptors, chronic health conditions, and adaptive functioning.[18] The children underwent a complete physical and neurologic examinations. Psychometric testing included the Mental Processing Composite of the Kaufman Assessment Battery for Children as a measure of intelligence (IQ),[19] the Woodcock Johnson Academic Skills Cluster,[20] and 6 subtests of a developmental neuropsychological assessment, the NEPSY. A composite of the NEPSY was calculated as the mean of the subtest standard scores, as justified by results of factor analysis which indicated that the subtests loaded on a single factor.[21,22] All tests were scored according to the child's postnatal age. One blind child was not tested, and a score of 40 (3 standard deviations below the mean) was assigned to an additional 9 children who could not be tested, 7 because of cerebral palsy, and 2 because of severe retardation/autistic-type behavior.

The study protocol was approved by the Institutional Review Board of University Hospitals of Cleveland and written informed consent obtained from the parents.

Statistical Analysis

To compare behavior between the ELBW and NBW groups, Student's t test was used for continuous variables and Pearson χ^2, or Fisher's exact test for dichotomous outcomes. Wilcoxon rank sum tests were used when the data distribution was not normal. If 3 or more items of a specific disorder were not completed, a score for the disorder was not computed. This occurred in 1 subject for 6 disorders and 2 subjects for 4 disorders. In the analyses, we adjusted for socioeconomic status, race, and sex of the child because of known effects of these factors on behavior. As a measure of socioeconomic status, we used the mean of the sample z scores of median family income according to the 2000 census tract of the family's residence and of years of education reported by the mother.[13] To identify correlates of the behavioral disorders that differed significantly between the ELBW and NBW subjects, Pearson or point biserial correlations between sociodemographic and neonatal variables and the CSI symptom severity scores of the identified disorders were calculated. Multivariable linear regression analyses of the significant variables were then performed adjusting for socioeconomic status, race, and sex.

RESULTS

Comparison of Demographic and Birth Data and 8-Year Outcomes

The extremely low birth weight (ELBW) and normal birth weight (NBW) children did not differ significantly with regard to their mothers' age, marital status, level of education, race, mean of the median family income, or mean percent of families living below the poverty level of the neighborhood in which the family resided (Table 2). The ELBW children had a mean birth weight of 810 g and a mean gestational age of 26.4 weeks. Neonatal complications included bronchopulmonary dysplasia (oxygen dependence at 36 weeks conceptual age) in 93 (43%) children, septicemia in 108 (49%), necrotizing enterocolitis in 11 (5%), and a severely abnormal cerebral ultrasound with either Grade III–IV periventricular hemorrhage, periventricular leucomalacia and/or ventricular dilatation at discharge in 51 (23%).

The ELBW children were studied at a significantly younger postnatal age than the NBW controls (8.7 ± 0.6 vs 9.2 ± 0.8 years, $p < .001$) because the NBW children could only be recruited after the school of the ELBW child had been verified so that matching could occur. Thirty-six (16%) ELBW children had major neurosensory impairments, including cerebral palsy in 31, deafness requiring hearing aids in 4, and blindness in 1. None of the NBW children had these impairments. The ELBW children also had significantly higher rates of low IQ and poor academic achievement. Information on other specific health and developmental outcomes has previously been published.[13,22–24]

CSI-4 Symptom Severity Scores

ELBW children had significantly higher scores than NBW children for the inattentive, hyperactive, and combined types of attention-deficit hyperactivity disorder (ADHD) (Table 3). They also had significantly higher scores for Generalized Anxiety and Autistic and Asperger's Disorders. The significant differences were evident among both girls and boys with the exception of Generalized Anxiety that pertained only to girls. When the 36 children with neurosensory abnormalities were excluded, the differences between the ELBW and NBW children remained significant. They also remained significant when children with neurosensory abnormalities and an IQ <85 were excluded.

DSM-IV Criteria Scores

Symptom count scores meeting DSM-IV criteria were twice as common in the ELBW group than in the NBW group. Thirty-two percent of the ELBW versus 15% of the NBW children had at least one disorder of whom 41 (19%) ELBW versus 14 (8%) NBW subjects had one disorder, 15 (7%) versus 7 (4%) 2 disorders, and 12 (6%) versus 6 (3%) 3 or more disorders ($p = 0.003$). These differences remained significant when children with neurosensory abnormalities were excluded and when both neurosensory abnormalities and/or an IQ <85 were excluded. The differences were similar for boys and girls.

When we considered specific disorders according to DSM-IV criteria, ELBW children had significantly higher rates of ADHD of any type due to higher rates of the inattentive and combined types of ADHD (Table 3). They also had more specific phobias. When the neurosensory-impaired ELBW children were excluded from the analyses, the significant differences in the rates of ADHD between the ELBW and NBW children persisted but the differences in the rates of anxiety became insignificant. When children with neurosensory abnormalities and/or an IQ <85 were excluded, the overall rates of having any type of ADHD remained significant (ELBW 12% vs NBW 3%, $p < .01$) but not the differences in the specific subtypes of ADHD.

Symptomatology Pertaining to Pervasive Developmental Disorders

Four ELBW children fulfilled the criteria for the Autistic disorder and 3 for Asperger's disorder. One additional ELBW child who had 6 symptoms did not met criteria for Autism and was considered to have PDD not otherwise specified. One NBW child fulfilled the criteria for Autistic disorder (Table 4). Parents of 3 of the ELBW children who fulfilled the criteria for the Autistic disorder and one with Asperger's had previously been told that their children had the condition.

Of the 12 symptoms pertaining to the Autistic and Asperger's disorders coded as "often" or "very often," 32 (15%) ELBW versus 12 (7%) NBW children had 1 to 2 symptoms, 13 (6%) versus 4 (2%) had 3 to 5 symptoms, and 5 (2%) versus 1 (0.6%) had between 6 and 10 symptoms ($p = .006$). The presence of 1 to 2 symptoms coded as "often" or "very often," which was more common among the ELBW children, could possibly be considered as "subclinical" for PDD.

Table 4 presents detailed information pertaining to the 8 children who fulfilled the criteria for PDD. All 4 ELBW children with the Autistic disorder had bronchopulmonary dysplasia and 3 had cerebral palsy. All 4 had severe cognitive impairment and subnormal scores on the Academic Skills Cluster[20] and Adaptive Behavior Scale.[18] At 20 months corrected age they were not testable on the Bayley II Scales of Infant Development due to severe impairment and assigned scores of <50.[25] At age 8 years, 3 children with Autistic disorder remained untestable and were assigned Mental Processing Composite scores of 40 (<3 standard deviations).[19] The children with Asperger's were neurologically normal and had Mental Developmental Indices in the borderline range at 20 months and cognitive scores in the low normal range at 8 years. All 8 children had one or more comorbid behavioral diagnoses. These included ADHD in 7 of the 8 ELBW children. Comparison of the 8 ELBW children identified with PDD with the rest of the population revealed no differences in the rates of multiple births, sex of the child, severely abnormal neonatal cerebral ultrasound, postnatal steroid administration, or duration of the neonatal hospital stay (data not given). The only significant risk factor identified was bronchopulmonary dysplasia (7 [88%] vs 86 [41%], $p = .02$).

Correlates of Symptom Severity Scores in the ELBW Population

For ADHD, Pearson or point biserial correlations revealed that lower socioeconomic status was significantly ($p < .05$) associated with all 3 types of ADHD, race was not associated, whereas male sex was associated with the hyperactive type of ADHD. None of the neonatal risk factors including bronchopulmonary dysplasia, jaundice, sepsis, necrotizing enterocolitis, severe cerebral ultrasound abnormality, or small for gestational age status were associated with any of the 3 types of ADHD. However, the log duration of neonatal hospitalization, which can be considered as a measure of overall neonatal risk, was associated with the combined type of ADHD ($r = .13$, $p < .05$). This correlation was no longer significant after adjusting for socioeconomic status, race, and sex of the child, (Unstandardized beta coefficient 1.37, confidence interval −0.57–3.32).

No significant sociodemographic or neonatal risk factors were identified for General Anxiety Disorder. When the Autistic and Asperger's were considered there was a significant negative correlation between the symptom severity scores and socioeconomic status. Male sex was weakly associated with the symptom severity score for Asperger's but not with that for the Autistic disorder. Neonatal risk factors that correlated significantly with both the Autistic and Asperger's Symptom Severity Scores included bronchopulmonary dysplasia, log days of postnatal steroids given for bronchopulmonary dysplasia, and log of the duration of neonatal hospital stay. None of the other peri- or neonatal risk factors considered (see earlier) were significant. After adjusting for socioeconomic status (SES), race, and sex of the child, the only neonatal risk factor that remained significant for Autistic symptomatology was bronchopulmonary dysplasia (unstandardized beta coefficient 1.43 [95% confidence interval 0.09 –2.78], $p = .04$). None of the risk factors were significant for Asperger's symptomatology after adjusting for SES, race, and sex of the child.

DISCUSSION

This is the first report of the behavioral outcomes of extremely low birth weight (ELBW) children at school-age born in the United States since 1990. Results reveal that ELBW children continue to have significantly more behavioral problems than normal birth weight (NBW) children as evidenced by a higher number of symptoms pertaining to the attention, hyperactive, and combined subtypes of attention-deficit hyperactivity disorder (ADHD), to General Anxiety Disorder and to the Autistic and Asperger's disorders. ELBW children also had twice as many symptom counts meeting DSM-IV criteria than their NBW counterparts, particularly for the inattentive and combined types of ADHD and specific phobias.

Our findings of an increase in behavioral disorders among ELBW children relative to NBW children are similar to those reported for other preterm populations born since 1990 in Australia, Sweden, and the United Kingdom.[4–6] Follow-up of children born before 1990s revealed that the most common problems pertained to weaknesses in attention and hyperactivity,[26–37] anxiety and depression,[27,29,30,35,36,38,39] and poor social skills.[28,30–32,35,40,41] With the exception of an increase in symptomatology suggestive of Autistic and Asperger's disorders, the type of behavioral problems reported for preterm children born in the 1990s are thus similar to those of children born in the 1980s. However, geographic and cultural differences between study cohorts,[31] as well as variation in the behavioral questionnaires used, make it difficult to assess whether the prevalence of the various problems has changed. Of note also is the fact that with the exception of 2 studies, diagnostic psychiatric evaluations have not been performed.[29,37]

Inattentive ADHD was the most common type of ADHD seen in our ELBW population. Furthermore fewer of our ELBW than NBW children presented with comorbid diagnoses of ADHD and conduct/oppositional disorders. These findings confirm those of Szatmari et

al[27,30,34] suggesting that the type of ADHD typically reported for preterm children pertains to attention difficulties rather than hyperactivity per se with no increase in comorbid conduct disorders. It has been suggested that the fewer comorbid disruptive behavioral disorders seen in pre-term children suggest a "purer" or more biological determined type of ADHD.[34,42,43] We did not, however, find a relationship between cerebral ultrasound abnormalities or other neonatal risk factors and ADHD. The literature has been mixed in this regard with some reporting an association between ADHD and cerebral ultrasound[31,37,44] or magnetic resonance imaging abnormality[45] and others no relation to neonatal risk factors.[27,30,32]

The increased incidence of Autistic Spectrum Disorders (ASD), otherwise termed pervasive developmental disorder (PDD), reported nationally since the 1990s is considered to be mainly due to increased awareness and improved and earlier ascertainment following the introduction of ICD-10 and DSM-IV diagnostic criteria for ASD in the early 1990s.[46,47] Recent estimates by the Center for Disease Control note that 6.6 of 1000 children who were 8 years old in 2000 had ASD.[48] Our finding of one child or 0.6% of our NBW population so affected is in agreement with the Center for Disease Control estimates.

Studies of preterm children at school age have previously reported that they have poor social skills. Preterm children tend to be socially isolated, to play by themselves, are less likely to initiate social behaviors and have poorly developed adaptive skills.[35,40,49] The majority of previous studies administered questionnaires that did not include symptoms of the Autistic or Asperger's disorder. This, rather than a current increase in prevalence, could possibly explain the paucity of previous reports pertaining to these conditions. In addition to Johnson et al.'s study,[8] 2 school-age studies have previously screened for ASD, both in Norway. Indredavik et al[29,50] reported a significantly higher mean sum score on the Autism Spectrum Screening Questionnaire among adolescents with birth weights <1.5 kg compared with controls. Four of 56 children were above the 75th criteria for Asperger's with 1 (2%) at the diagnostic level.[29] All 4 children had white matter reduction and ventricular dilatation on magnetic resonance imaging.[45] Elgen et al[30,51] administered the Asperger's Syndrome Diagnostic Interview to parents of 130 11-year-old <2 kg birth weight children and found 1 child (1%) to have Asperger's compared with none of the controls. In addition, Moster et al[52] recently reported on Norwegian national outcomes for adults born 1967 to 1983 and found a higher risk for disability payments for autism at less than 30 weeks gestation compared with term born adults. None of the studies reported to date have administered confirmatory diagnostic tests for Autism. Older studies of preterm children, many involving samples with high rates of severe mental retardation and cerebral palsy, noted a relationship between autism and blindness due to retinopathy of prematurity,[53] and infantile hydrocephalus.[54]

Ours is the first detailed clinical description of school-age preterm children who present with symptoms suggestive of the Autistic or Asperger's disorders. The only neonatal risk factor that we found to be significantly associated with both Autistic Symptom Severity Scores and Autistic disorder based on DSM-IV Symptom Counts criteria was bronchopulmonary dysplasia defined as oxygen dependence at 36 weeks corrected age.

Epidemiologic studies have previously suggested an association between autism and preterm birth and/or low birth weight (<2.5 kg).[55–58] Additional factors identified have included hypertension of pregnancy, intra-uterine bleeding, fetal distress, cesarean section, Apgar score of <7, oxygen requirement at birth, small size for gestational age, and congenital malformations.[55,56,59,60] ELBW children, in addition to being born preterm, experience many of these pregnancy, delivery, and neonatal risk factors which may be associated with hypoxia. The association of autism with perinatal hypoxia is also consistent with its reported association with neonatal encephalopathy[61] and our finding of higher rates of chronic lung

disease which usually results from severe respiratory distress syndrome and may be associated with recurrent episodes of oxygen desaturation. Recent reports of genetic abnormalities in children with Autism[62] have led to the hypothesis that it may result from a genetic predisposition to the condition, together with obstetric and perinatal complications which may adversely affect perinatal development.[63]

Strengths of this study include our high follow-up return rates of 90%, the detailed description of children with symptoms suggestive of Autistic and Asperger's disorders and the use of the Child Symptom Inventory-4 which allows for Symptom Severity Scores that may be more sensitive to deviations in behavior than cutoff scores used to provide diagnoses. Weaknesses of the study include the lack of a clinical psychiatric assessment, which is needed to make definitive diagnoses. Our results are based on parent report only. The questions in the Child Symptom Inventory-4 provide only a limited screen for Autistic and Asperger's disorders and we lack a formal structured diagnostic interview such as the Autism Diagnostic Interview-Revised.[64] Magnetic resonance imaging studies during the neonatal period or later at school age may have provided a more sensitive measure of brain injury than neonatal cerebral ultrasound.[65] Although the sensitivity scores for the Autistic and Asperger's disorders among the ELBW children were significantly higher than those of NBW children, we may have underestimated the DSM-IV criteria rates of these disorders. The parent Child Symptom Inventory has however been shown to have a specificity of 0.99 for Autism and 3 of 4 of our children with Autism had previously been identified with this condition.

In conclusion, ELBW children born in the 1990s continue to suffer from higher rates of ADHD and anxiety disorders than NBW children. Furthermore our results, together with those reported in the literature, suggest an increase in symptoms suggestive of PDD/ASD in ELBW children which was not previously recognized. Future long-term studies of preterm children will need to include larger populations of children and to administer formal diagnostic measures of PDD/ASD at school age to confirm the diagnosis. Structural and functional magnetic resonance imaging studies of ELBW children may also in the future help identify specific abnormalities associated with ADHD and/or ASD/PDD.

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Table 1

Items for Autistic Disorder (Category H) in CSI-4 and DSM-IV

	CSI-4	DSM-IV Criteria
Social interaction	72. Has a peculiar way of relating to others (avoids eye contact, odd facial expressions, or gestures)	1A. Marked impairment in the use of multiple nonverbal behavior such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
	73. Does not play or relate well with other children	1B. Failure to develop peer relationships appropriate to developmental level
	74. Not interested in making friends	1C. A lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
	75. Is unaware or takes no interest in other people's feelings	1D. Lack of social or emotional reciprocity
Communication/language	76. Has a significant problem with language	2A. Delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)
	77. Has difficulty making socially appropriate conversation	2B. In individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
	78. Talks in a strange way (repeats what others say; confuses words like "you" and "I"; uses odd words or phrases)	2C. Stereotyped and repetitive use of language or idiosyncratic language
	79. Is unable to "pretend" or "make believe" when playing	2d. Lack of varied, spontaneous make- believe play or social imitative play appropriate to developmental level
Repetitive and stereotypical behaviors	80. Shows excessive preoccupation with one topic	3A. Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
	81. Gets very upset over small changes in routine or surroundings	3B. Apparently inflexible adherence to specific, nonfunctional routines or rituals
	82. Makes strange repetitive movements (flapping arms)	3C. Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole body movements
	83. Has strange fascination for parts of objects	3D. Persistent preoccupation with parts of objects

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Table 2

Maternal Demographic Risk Factors, Perinatal Data, and 8-Year Outcomes

	Extremely Low Birth Weight (n = 219)	Normal Birth Weight (n = 176)
Maternal demographic data[a]		
Age (yrs)[b]	38 ± 9	35 ± 8
Married	114 (52%)	87 (49%)
Education		
<High school	26 (12%)	22 (13%)
High school	63 (29%)	44 (25%)
>High school	130 (59%)	110 (63%)
Race		
White[c]	83 (38%)	58 (33%)
Black	136 (62%)	118 (67%)
Mean percent below poverty level[d]	18 ± 16%	20 ± 17%
Mean family income ($± SD)[e]	39.9 ± 20	36.8 ± 21
Perinatal data		
Birth weight (g ± SD)	810 ± 124	3300 ± 513*
Gestational age (wk ± SD)	26.4 ± 2	≥37 wks*
Female sex	130 (59%)	111 (63%)
Multiple birth	39 (18%)	0
8-year outcomes		
Neurosensory impairment	36/219 (16%)	1 (0.4%)**
Low intelligence <85 (19)	84 (38%)	25 (14%)**
Poor academic achievement (20)	79/215 (37%)	27 (15%)**
Asthma[f]	47/219 (21%)	15/176 (9%)***

ELBW, extremely low birth weight; NBW, normal birth weight.

* $p < .05$,

** $p < .005$,

*** $p < .001$.

[a] Unless otherwise stated refers to primary caregiver which for 195 (89%) of the extremely low birth weight and 157 (89%) of the normal birth weight groups was the biologic or adoptive mother.

[b] Biologic and adoptive mothers only.

[c] Includes 2 Asian ELBW and 2 Asian NBW mothers.

[d] Mean percent of families below the poverty level according to the 2000 Census tract neighborhood in which the families lived.

[e] Mean of median family income in 1000s of dollars according to the 2000 Census tract.

[f] Requiring treatment at age 8 years.

Table 3

Parent Report of Symptom Severity Scores and Screening DSM-IV Criteria Cutoff Scores

	Symptom Severity Scores[a, b]			Cutoff Scores[a]		
	ELBW (n = 219)[c]	NBW (n = 176)	Effect Size[d]	ELBW (n = 219)[c]	NBW (n = 176)	OR (95% CI)[e]
ADHD (any)	—	—	—	37 (17%)	9 (5%)*	4.2 (1.9–9.1)
Inattentive	9.6 ± 5.9	6.2 ± 4.4*	0.79	21 (10%)	5 (3%)**	4.1 (1.5–11.1)
Hyperactive	7.0 ± 5.3	5.1 ± 4.6*	0.42	6 (3%)	3 (2%)	1.9 (0.5–8.0)
Combined	16.6 ± 10.2	11.2 ± 8.3*	0.65	10 (5%)	1 (0.6%)***	8.1 (1.0–64.6)
Oppositional defiant	5.1 ± 3.9	4.5 ± 3.8	0.15	12 (6%)	11 (6%)	0.9 (0.4–2.1)
Conduct disorder	1.0 ± 1.7	1.1 ± 2.1	−0.02	19 (9%)	16 (9%)	1.0 (0.5–2.0)
Generalized anxiety[f]	3.7 ± 3.2	2.7 ± 2.5**	0.38	7 (3%)	2 (1%)	3.1 (0.6–15.5)
Major depressive[g]	10.2 ± 1.7	10.3 ± 1.6	−0.03	4 (2%)	1 (0.6%)	3.4 (0.4–31.5)
Autistic disorder	3.7 ± 5.0	2.0 ± 3.5*	0.49	4 (2%)	1 (0.6%)	3.1 (0.3–27.9)
Asperger's disorder	2.5 ± 3.2	1.5 ± 2.5**	0.39	3 (1%)	0 (0%)	—
Social phobia	1.9 ± 1.9	1.5 ± 1.7	0.24	16 (7%)	6 (3%)	2.9 (1.1–7.8)
Separation anxiety	1.9 ± 2.7	1.8 ± 2.7	0.06	9 (4%)	6 (3%)	1.4 (0.5–4.2)
Specific phobia	—	—	—	108 (50%)	69 (39%)***	1.6 (1.1–2.4)
Motor tics	—	—	—	29 (13%)	15 (9%)	1.8 (0.9–3.6)
Vocal tics	—	—	—	48 (22%)	35 (20%)	1.2 (0.7–2.1)

ELBW, extremely low birth weight; NBW, normal birth weight; ADHD, attention-deficit hyperactivity disorder.

* $p < .001$,

** $p < .01$,

*** $p < .05$.

[a] Adjusted for sociodemographic status, race and sex.

[b] Higher scores indicate poorer behavior.

[c] n = 217–219 since data were missing for certain disorders.

[d] Effect sizes were calculated as the adjusted mean difference between the ELBW and NBW scores divided by the SD of the NBW group. Effect sizes translate differences in behavior into standardized units.

[e]Odds ratios (95% confidence interval) adjusted for sociodemographic status, child race, and sex.

[f]Three or more symptoms.

[g]Five or more symptoms.

Table 4

Birth Data, Neonatal Complications, 20 months and 8-Year Outcomes of Children with Pervasive Developmental Disorders

	Birth Data and Neonatal Complications							20-Month Development		8-Year Outcomes			
	Birth Weight	**Gest. Age**	**Multiple Birth**	**Race**	**Sex**	**BPD**	**Abn. US**	**MDI**	**Neurologic Abnormality**	**MPC**	**WJAA**	**VAS**	**Comorbidity**
ELBW													
Autistic disorder													
Case 1	909 g	27 wks		Black	F	+	+	<50	Quadriplegia hydrocephalus	40[a]	40	30	Combined ADHD
Case 2	811 g	27 wks	Twin	Black	M	+	−	<50	Hemiplegia	51	41	33	Inattentive ADHD
Case 3	843 g	26 wks	Quad	Asian	M	+	−	<50	Normal	40[a]	40	32	Combined ADHD
Case 4	706 g	25 wks		White	M	+	−	<50	Quadriplegia	40[a]	40	32	Combined ADHD, major depression
Asperger's disorder													
Case 5	839 g	27 wks		Black	M	+	−	69	Normal	78	61	52	Social phobia
Case 6	573 g	23 wks	Twin	White	M	+	+	79	Normal	78	110	73	Combined ADHD, oppositional/defiant
Case 7	918 g	27 wks		Black	F	−	−	67	Normal	87	96	48	Inattentive ADHD, anxiety, social phobia
NOS													
Case 8	775 g	25 wks		Black	M	+	+	86	Normal	100	90	56	Inattentive ADHD, conductive disorder, oppositional/defiant
NBW	3.4 kg	Term		Black	F	−	−	NA	Normal	73	57	56	Hyperactive ADHD, opposition conduct, anxiety, social phobia

ELBW, extremely low birth weight; NBW, normal birth weight; NOS, not otherwise specified; Gest. Age, gestational age; M, male; F, female; BPD, bronchopulmonary dysplasia (O_2 dependence at 36 weeks); Abn. US, severely abnormal cerebral ultrasound (including grade III–IV hemorrhage, periventricular leucomalacia and ventricular dilatation at discharge); MDI, Mental Development Index[25]; PDI, Psychomotor Development Index[37]; ADHD, attention-deficit hyperactivity disorder; MPC, Mental Processing Composite[19]; WJAA, Woodcock Johnson Scales of Academic Achievement[20]; VAS, Vineland Adaptive Scales.[18],

[a]Estimated at <3 standard deviation.