ARTICLE

The Incidence of Autism in Olmsted County, Minnesota, 1976-1997

Results From a Population-Based Study

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Objective: To determine the incidence of autism among children in Olmsted County, Minnesota.

Design: Through the Rochester Epidemiology Project, all inpatient and outpatient diagnoses are indexed for computerized retrieval. This computerized diagnostic index was used to identify children with any developmental disorder. A glossary of symptoms of autism was used to review medical and school records of these children for symptoms consistent with *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*) criteria for autistic disorder.

Setting: Olmsted County, Minnesota.

Subjects: All residents of Olmsted County 21 years or younger between 1976 and 1997.

Main Outcome Measure: The incidence of research-identified autism based on *DSM-IV* criteria for autistic disorder.

Results: The age-adjusted incidence of research-identified autism was 5.5 (95% confidence interval, 1.4-9.5) per 100 000 chidren from 1980 to 1983 and 44.9 (95% confidence interval, 32.9-56.9) from 1995 to 1997 (8.2-fold increase). This increase was confined to children younger than 10 years who were born after 1987.

Conclusions: The incidence of research-identified autism increased in Olmsted County from 1976 to 1997, with the increase occurring among young children after the introduction of broader, more precise diagnostic criteria, increased availability of services, and increased awareness of autism. Although it is possible that unidentified environmental factors have contributed to an increase in autism, the timing of the increase suggests that it may be due to improved awareness, changes in diagnostic criteria, and availability of services, leading to identification of previously unrecognized young children with autism.

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AUTISM IS A DEVELOPMENTAL disorder characterized by severe impairment in reciprocal social interaction and communication and a pattern of repetitive or stereotyped behavior.[1] There has been widespread concern about an apparent increase in the prevalence of autism.[2-6] Studies from the 1980s and early 1990s reported a prevalence of approximately 4 to 10 per 10 000 children, whereas recent studies have reported much higher prevalences of 30 to 50 per 10 000 children.[7-26] It has been suggested that the reported increase in prevalence may be due to the introduction of less restrictive diagnostic criteria, beginning with the *Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition* (*DSM-III-R*) in 1987.[2-4,27-29] Recently, Gurney et al[30] demonstrated that the prevalence of children receiving special education services for autism spectrum disorders increased subsequent to the 1991 changes in the federal special education law. Although prevalence data are often used to assess time trends for a disease, changes in diagnostic criteria and awareness of autism may make it inappropriate to compare prevalence figures across time.[2-4,31]

To appropriately assess potential changes in the occurrence of autism, a population-based incidence study is needed, with case-finding strategies that use contemporary diagnostic criteria and do not rely on clinically diagnosed samples.[2-4,29] Incidence rate is defined as "the number of new cases of a disease in a population over a period of

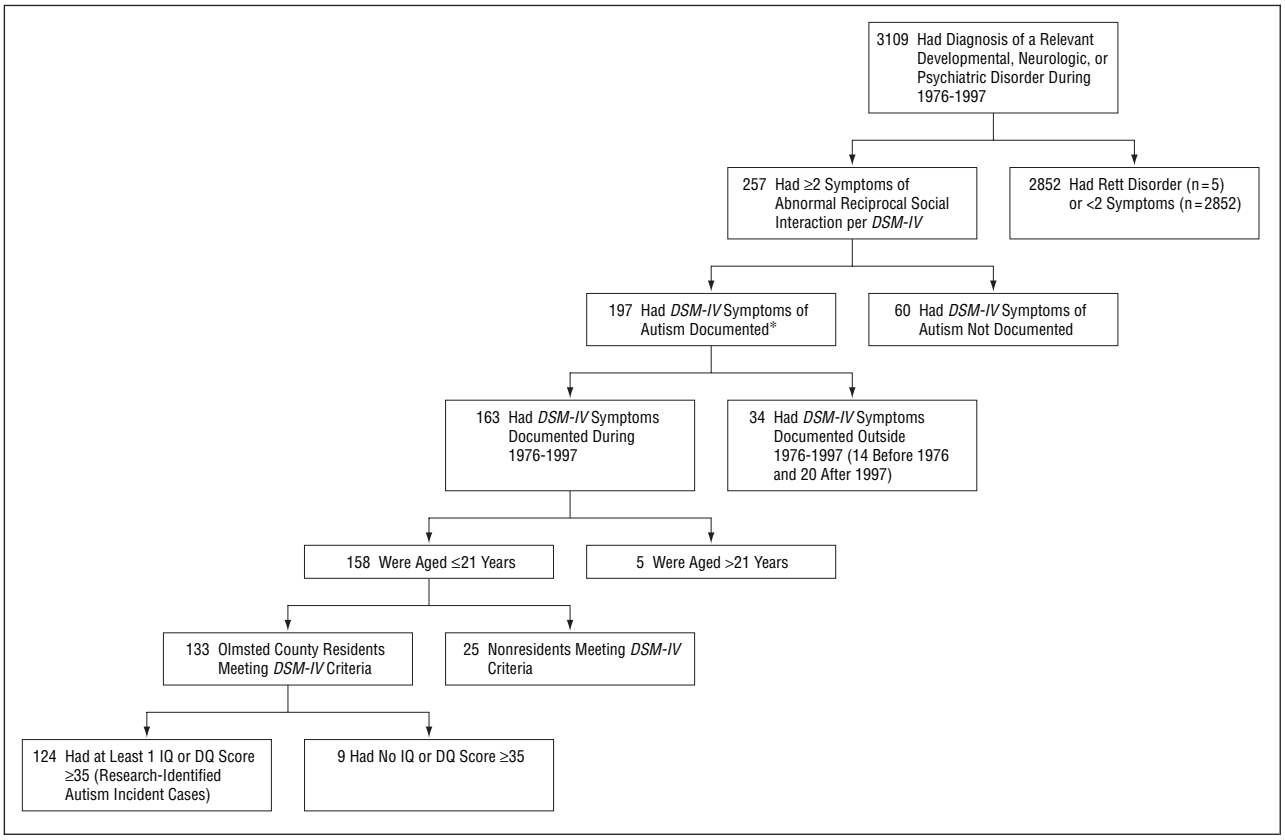

Figure 1. Flow diagram of ascertainment of research-identified autism incident cases among residents of Olmsted County, Minnesota, 21 years or younger between 1976 and 1997. Asterisk indicates at least 2 unique symptoms of impaired reciprocal social interaction, at least 1 symptom of impaired communication, at least 1 symptom of unusual or repetitive behavior, and a total of at least 6 unique symptoms of autism; *DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*; and DQ, developmental quotient.

time."[31(pp126-127)] Incidence studies are necessary to examine the relationship between etiologic factors and disease, estimate individual risk of acquiring a particular disease, and study historical trends in disease frequency.[31] If changes in the incidence of autism are due to increased awareness generated by the publication of the *DSM-III-R* in 1987 and the 1991 revisions in the special education laws, then any increase in the incidence of autism should occur after these years.[28,32] Before the dissemination of broader and more precise diagnostic criteria, children with autism may have been given less precise diagnoses, such as "developmental delay" or "mental retardation." Children with milder symptoms of autism may not have been identified at all. Furthermore, if increased awareness of developmental disorders and availability of services lead to an increase in the identification of such children, this effect should be seen for other developmental disorders included in the first federal special education law in 1975, as well as for autism.[32]

To assess these time trends, we report the incidence of autism from 1976 to 1997 based on documentation in medical and school records for residents of Olmsted County, Minnesota. We use the term *autism* to refer to autistic disorder, as specified in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*).[1] We use the term *autism spectrum* to refer to autistic disorder, pervasive developmental disorder–not otherwise specified, and Asperger disorder combined (per the *DSM-IV*).

METHODS

STUDY SETTING AND SUBJECTS

More than 95% of all medical care in Olmsted County, Minnesota, is provided locally by the Mayo Clinic and Olmsted Medical Center. Through the Rochester Epidemiology Project, all inpatient and outpatient diagnoses are indexed for computerized retrieval (Medical Diagnostic Index).[33] The population is characterized by virtually universal access to high-quality health care; hence, medical records are available for more than 95% of residents of the county. Medical records contain complete, detailed information from health care practices of all care to county residents, including developmental, psychiatric, neurologic, and psychologic assessments. Medical records also contain documentation from all well-child visits, including information on developmental progress and problems. All public and private school records are available though a contractual agreement. School records include notations from teachers, parents, and school psychologists related to any developmental or learning problem, cognitive assessments, or information related to special education services.

Subjects included all residents of Olmsted County 21 years or younger in each year from 1976 to 1997 (n=34 944 in 1976 and 37 726 in 1997). The protocol was approved by the institutional review board. The population of Rochester was approximately 98% white between 1976 and 1997.[34] Previously, we studied the migration of children in Olmsted County; 70% of children born in the county remain until at least age 5 years, with little additional migration by age 10 years.[34]

ASCERTAINMENT OF RESEARCH-IDENTIFIED AUTISM INCIDENT CASES

Phase 1: Development of Screening Tools

We first compiled a list of all developmental, psychiatric, and neurologic diagnoses (n=80, available from the authors) ever applied to a group of 182 children younger than 18 years, with autistic disorder or pervasive developmental disorder–not otherwise specified, consistent with *DSM-IV* criteria, who had been evaluated at the Mayo Clinic by developmental and behavioral pediatricians, child psychologists, child psychiatrists, or child neurologists between 1994 and 1998.[35] In addition to autism spectrum diagnoses, other common diagnoses included, for example, mental retardation, developmental delay, and language disorders. We reviewed the medical records of these 182 patients, transcribing every reference to symptoms of autism, to create a 20-page glossary of phrases consistent with the symptoms of autistic disorder as specified in the *DSM-IV*[1] (available from the authors). For example, the phrase "is preoccupied with lining up objects instead of playing with them" would be coded as the *DSM-IV* symptom "apparently inflexible adherence to specific, nonfunctional routines or rituals."[1(p71)] This approach is consistent with the strategy used in the most recent US study of the prevalence of autism.[5]

Phase 2: Identification of Autism Incident Cases Using Research Criteria

We used the Medical Diagnostic Index to identify 3109 residents of Olmsted County 21 years or younger between 1976 and 1997 who had ever been diagnosed as having any 1 of the 80 clinical conditions described herein (**Figure 1**). We then reviewed the medical records of these 3109 residents using the glossary of autism symptoms.

We identified 257 children whose records included at least 2 symptoms of "impairment in reciprocal social interaction."[1(p66)] For each of these 257 children, we reviewed the medical and school records, recording every symptom from the glossary of *DSM-IV* symptoms. To be considered an incident case of research-identified autism, the child had to fulfill the following criteria: (1) no clinical diagnosis of Rett disorder or childhood disintegrative disorder; (2) symptoms required for a *DSM-IV* diagnosis of autistic disorder documented between January 1, 1976, and December 31, 1997 (ie, at least 2 symptoms of impaired reciprocal social interaction; at least 1 symptom of impaired communication and restricted, repetitive, and stereotyped behavior, interests, or activities; and a total of at least 6 symptoms); (3) age of 21 years or younger and a resident of Olmsted County when *DSM-IV* criteria were fulfilled; (4) no clinical diagnosis of schizophrenia preceding the date at which the *DSM-IV* criteria were fulfilled; (5) at least 1 IQ of 35 or higher. These criteria are consistent with *DSM-IV* guidelines for diagnosis of autistic disorder. According to the *DSM-IV*, "it is sometimes difficult to determine whether an additional diagnosis of autistic disorder is warranted in an individual with mental retardation, especially if the mental retardation is severe or profound."[1(p70)] In a retrospective study, it was not possible to make this distinction; therefore, we excluded children with severe to profound mental retardation. However, we identified all children with severe to profound mental retardation who otherwise fulfilled research criteria (n=9) (Figure 1). We did not require that symptoms were documented before the age of 3 years, since we could not precisely ascertain the age at which the symptoms first occurred. The incidence date for each case was defined as the date at which the child had documented symptoms required for autistic disorder, as defined herein. One hundred ninety-seven children had symptoms consistent with *DSM-IV* criteria for autistic disorder; 34 of these children were excluded because they did not have all symptoms documented between 1976 and 1997, and 25 were excluded because they were not residents when they met other research criteria (Figure 1). One hundred twenty-four children fulfilled our criteria for research-identified autism.

Table 1. Cognitive Profile of Research-Identified Autism Incident Cases*

Level of Cognitive Functioning	Boys, No.	Girls, No.	Total, No. (%) (N = 112)	Male-Female Ratio
No cognitive impairment (IQ>70)†	**34**	**10**	**44** (39.3)	3.4
IQ test				
IQ>110	1	0	**1** (0.9)	
IQ 90-110	9	3	**12** (10.7)	3.0
IQ 71-89	23	7	**30** (26.8)	3.3
Developmental test				
IQ 71-89	**1**	**0**	**1** (0.9)	
Cognitive impairment (IQ≤70)‡	**52**	**16**	**68** (60.7)	3.3
IQ test				
IQ 50-70 (mild MR)	25	7	**32** (28.6)	3.6
IQ 35-49 (moderate MR)	17	5	**22** (19.6)	3.4
IQ 20-34 (severe MR)	5	1	**6** (5.4)	5.0
IQ<20 (profound MR)	0	1	**1** (0.9)	
Total				
Developmental test				
IQ 71-89 (profound MR)	1	0	**1** (0.9)	
IQ 50-70 (mild MR)	4	1	**5** (4.5)	4.0
IQ 35-49 (moderate MR)	1	0	**1** (0.9)	
IQ 20-34 (severe MR)	0	1	**1** (0.9)	

Abbreviation: MR, mental retardation.

*Of the 124 children, 112 had either an IQ or a developmental quotient measured within ±1.5 years of the date the child fulfilled the criteria for research-identified autism.

†The mean (SD) age of testing in this group was 8.7 (4.6) years.

‡The mean (SD) age of testing in this group was 5.9 (4.2) years. The closest IQ or developmental quotient within the ±1.5-year window was less than 35 for 8 of the 112 children. However, these 8 children also had at least 1 IQ of 35 or higher.

RESEARCH-IDENTIFIED AUTISM INCIDENT CASES

Among the 124 children with research-identified autism, 112 had an IQ or a developmental quotient measured within 1.5 years of the incidence date (**Table 1**). Most (n=104) had undergone a formal cognitive test. Boys (n=95) outnumbered girls (n=29) by 3.3 to 1. Children had their first documented autism symptom at a median age of 2.6 years. Of the 124 children, 106 (85.4%) had at least 1 symptom documented before age 5 years, with most (n=80, 64.5%) having their first documented symptom before age 3 years. We found that 48.1% of all abstracted symptoms were observed by medical professionals, 30.4% by school staff, and 20.9% by parents or caregivers. Most children (90.3%) had some symptoms documented in school records. As anticipated, many children with research-identified autism had not received a clinical diagnosis of autism. The most frequent diagnoses were developmental delay (n=44), delayed speech and language development (n=42), attention-deficit/hyperactivity disorder (n=24), and mental retardation (n=22). Comorbid epilepsy was identified in 17 cases (13.7%).

Table 2. Age- and Sex-Adjusted Incidence of Research-Identified Autism

Year	No. of Incident Cases	Incidence Rate Per 100 000 People (95% CI)*
1976-1979	0	0
1980-1983	7	5.5 (1.4-9.5)
1984-1987	11	7.9 (3.2-12.6)
1988-1991	18	11.8 (6.3-17.3)
1992-1994	34	29.4 (19.4-39.3)
1995-1997	54	44.9 (32.9-56.9)

Abbreviation: CI, confidence interval.
*Age- and sex-adjusted to the structure of the US white population 21 years or younger in 2000.

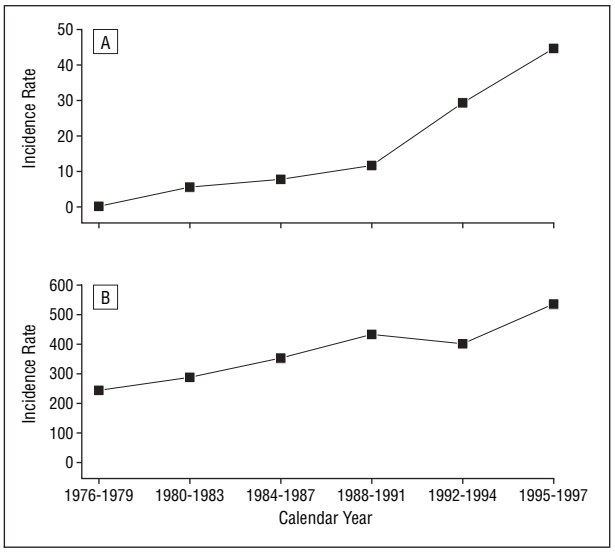

Figure 2. Overall age- and sex-adjusted incidence per 100 000 children by period of research-identified autism (A) and all other clinical diagnoses of developmental, neurologic, and psychiatric disorders (B) among residents of Olmsted County, Minnesota, between 1976 and 1997.

STATISTICAL ANALYSIS

Age- and sex-specific incidence rates were calculated by intervals, assuming all residents 21 years or younger in Olmsted County between 1976 and 1997 were at risk. The denominator was estimated using census data for 1970, 1980, 1990, and 2000, with linear interpolation for the intercensus years. Rates were age and sex adjusted to the structure of the US white population in 2000. We constructed 95% confidence intervals (CIs) for the incidence rates and the ratio of incidence rates, assuming a Poisson error distribution.

RESULTS

INCIDENCE OF RESEARCH-IDENTIFIED AUTISM

The age- and sex-adjusted incidence of research-identified autism increased from 5.5 per 100 000 children between 1980 and 1983 to 44.9 per 100 000 children from 1995 to 1997, an 8.2-fold (95% CI, 3.9- to 19.0-fold) increase (**Table 2**). Incidence was relatively stable from 1976 to 1988 but increased thereafter (**Figure 2**A). If children with severe to profound mental retardation had been included, the resulting rates would have been 5.5 per 100 000 children from 1980 to 1983 and 45.8 per 100 000 between 1995 and 1997.

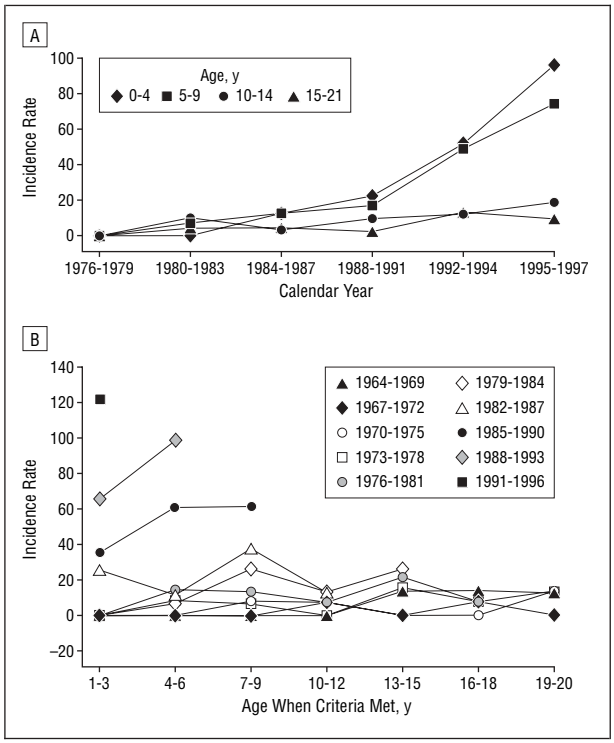

Figure 3. Age-specific (A) and birth cohort–specific (B) incidence of research-identified autism among residents of Olmsted County, Minnesota, between 1976 and 1997. B, There is a separate line for each birth cohort. The birth cohorts overlap, since intervals were used for age and the year a child met the criteria. For example, a child who met the criteria at age 1 to 3 years from 1986 to 1988 could have been born between 1982 and 1987, whereas a child who met the criteria at age 1 to 3 years from 1989 to 1991 could have been born between 1985 and 1990.

AGE- AND COHORT-SPECIFIC INCIDENCE OF RESEARCH-IDENTIFIED AUTISM

The mean age at which children fulfilled research criteria decreased from 13.1 years between 1980 and 1983 to 5.1 years from 1995 to 1997. The age-specific incidence of research-identified autism was stable from 1976 to 1997 for children aged 10 to 21 years. However, after the period from 1988 to 1991, incidence rates increased for children 10 years and younger (**Figure 3**A). Cohort-specific incidence rates were relatively low for children born before 1987, whereas rates were much higher for young children born after 1987 (Figure 3B).

COMPARISON OF RESEARCH-IDENTIFIED INCIDENT CASES ACROSS TIME

We compared mean cognitive scores and mean number of autism symptoms of incident cases across time and found no significant differences (**Figure 4**). Although we were able to identify the documented number of autism symptoms, we were not able to make a qualitative assessment about the severity of each symptom given the retrospective nature of the information.

INCIDENCE OF OTHER DEVELOPMENTAL DISORDERS

The incidence of all other clinical diagnoses of developmental, neurologic, or psychiatric disorders among children 21 years or younger (n=3109, before excluding the 124 research-identified autism incident cases and 5 Rett disorder cases) increased from 289.0 per 100 000 children in 1980 to 1983 to 530.1 per 100 000 children in 1995 to 1997, a 1.8-fold increase (95% CI, 1.6- to 2.1-fold; Figure 2B).

COMMENT

We studied the incidence of autism from 1976 to 1997 by retrospectively applying *DSM-IV* criteria for autistic disorder to residents of Olmsted County who were 21 years or younger and who had any diagnosis of a developmental, neurologic, or psychiatric disorder during these years. The 124 cases of research-identified autism manifested cognitive impairment (60.7%) and other comorbidities consistent with previous reports.[36] The capacity for population-based epidemiologic research on autism in Olmsted County is the result of a unique set of circumstances.[33] First, Olmsted County is relatively isolated in southeastern Minnesota; as a result, virtually all medical care received by the residents is provided locally by the Mayo Clinic and Olmsted Medical Center and their 3 affiliated hospitals. The medical records contain complete, detailed information, including documentation of all primary and specialty medical care provided to residents (eg, all developmental, psychiatric, neurologic, and psychologic assessments). Well-child visits, including routine developmental monitoring and screening, are recorded in the medical records. We also had access to school records from both public and private schools; 90.3% of subjects with research-identified autism had some symptoms documented in their school records.

To ensure that we identified all children who presented with symptoms consistent with *DSM-IV* criteria for autistic disorder, we examined the records of all children 21 years or younger who had any diagnosis of a developmental, neurologic, or psychiatric disorder. During the early years included in this study, some children did not have all documented symptoms required to fulfill *DSM-IV* criteria for autism until they were well beyond the age at which children are diagnosed as having autism in current clinical practice. This may have been due to the relative lack of awareness of autism in earlier years or the absence of educational and other services that would have motivated parents to bring their child's problems to the attention of health care professionals.[2,30,32] Therefore, we included as incident cases all children 21 years or younger who had newly documented symptoms consistent with our research criteria. Accordingly, incidence rates were calculated by intervals, assuming that all residents 21 years or younger were at risk. This does not imply that we believe that autism has its onset at age 10 years or older. However, in this community, during the early years included in this study, there were children whose symptoms were not documented in the medical and school records until they were beyond the age at which we now typically recognize symptoms of autism.

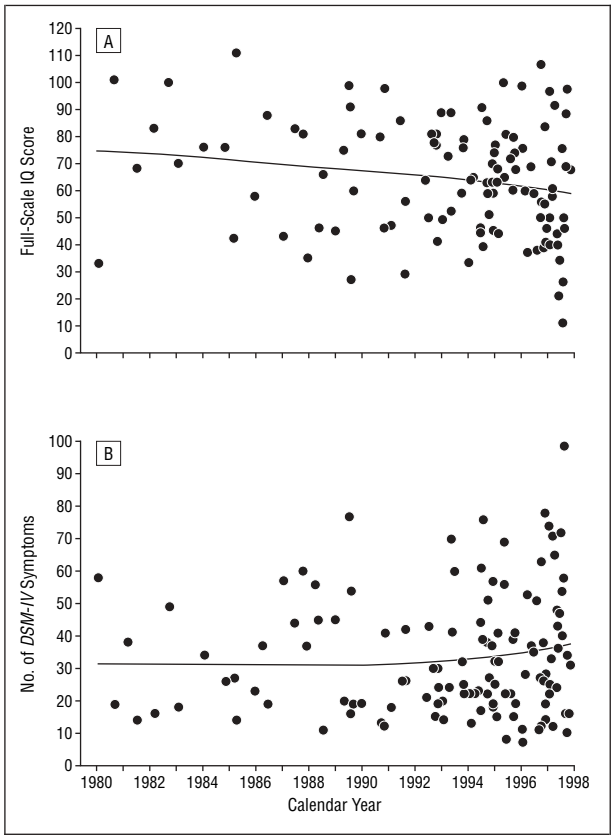

Figure 4. A, Among the 124 children, 112 had a full-scale IQ within 1.5 years of meeting research criteria for autism. Using each child's IQ closest to the date he or she met the study criteria, the graph depicts each child's IQ vs the year in which the child met the criteria. B, Number of *Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition* (*DSM-IV*) symptoms recorded between birth and up to 2 years after the child met the research criteria for autism vs the year in which the child met the criteria.

In this study, we defined incident cases based on the age and date at which the children had documented symptoms consistent with the *DSM-IV* symptoms of autistic disorder. The mean age at which our incident cases fulfilled research criteria was 13.1 years between 1980 and 1983 but decreased to 5.1 years from 1995 to 1997. We also found that the median age at which the first symptom was documented was 2.6 years. Most children had at least 1 symptom documented before age 3 years. We considered the age and date of each symptom to be the date at which the symptom was recorded in the medical or school record. Clearly, the symptoms would have manifested before they were documented. As noted in a review of the epidemiology of autism, "age of onset is very difficult to define and to ascertain"[2(p152)] both in clinical practice and in a retrospective research studies. We therefore did not require the subjects to have some symptoms documented before age 3 years to be considered as an incident case of research-identified autism.

Previous articles[2,3,29] have noted that it may be impossible to determine whether there has been a true increase in autism owing to reliance on prevalence as opposed to incidence studies. We found that the incidence of research-identified autism increased from 5.5 per

100 000 children between 1980 and 1983 to 44.9 per 100 000 children from 1995 to 1997 (8.2-fold increase). In the absence of other incidence studies, we compared our findings with reports of increased prevalence of autism.[31] In Minnesota, the prevalence of autism spectrum disorders reportedly increased from 3 per 10 000 children (aged 6 to 11 years) between 1991 and 1992 to 52 per 10 000 children from 2001 to 2002.[30] However, in this Minnesota study, prevalence was based on the number of children who received special education services for all autism spectrum disorders without independently ascertaining the prevalence of autism among all children in the state. We also compared our incidence rates with prevalence figures from a recent study in metropolitan Atlanta, Ga, that used similar case criteria. In 1997, among our 124 incident cases, 112 subjects were still 21 years or younger, corresponding to an overall age- and sex-adjusted prevalence of 29.0 per 10 000 people. The Atlanta study indicated a prevalence of all autism spectrum disorders of 34 per 10 000 children, which was comparable with our calculated prevalence of autistic disorder only.[5]

Two possible explanations for our finding of an increase in the incidence of autism in Olmsted County from 1976 to 1997 were considered. First, this finding may represent a true increase in the number of children affected by autism. This, in turn, may be attributed to some known or unknown environmental factor that has caused more children to develop autism.[2] Second, there may not have been a true increase in the incidence of autism; rather, increased awareness generated by the development of broader, more precise diagnostic criteria and the availability of educational and other services may have led more parents to bring their children's problems to the attention of health care professionals and schools.[1,2,27,28,30,32] These factors may also have led health care professionals and educators to increase their vigilance for symptoms of autism and therefore to document these symptoms in medical and school records. Before the era of increased awareness of autism, children with fewer or less severe symptoms may not have had their problems documented.

Environmental factors, including immunizations, have been implicated as possible causes for the reported increase of autism. However, recent studies[37-41] have failed to demonstrate an association between the measles-mumps-rubella (MMR) vaccine and autism; nevertheless, there continues to be widespread concern about the MMR vaccine as a potential risk factor for autism. In Minnesota, immunization against measles has been mandated for school entry since 1967, rubella since 1973, and mumps since 1978.[42-44] The MMR vaccine was licensed in 1971 and has since been the preferred vaccine.[45] However, the timing of the introduction of the MMR vaccine did not coincide with the increased incidence of autism in Olmsted County. There has also been concern that the immunization preservative thimerosal may cause autism.[40,46] Recently, a Danish study[46] demonstrated that the incidence of autism was stable from 1971 to 1990, increasing thereafter. In Denmark, thimerosal was removed from the market in 1992, but the increase in autism continued through 2000.[46] We did not determine vaccination status for our subjects; however, Minnesota law requires completion of vaccination before school entry. The timing and magnitude of the increase in autism in our study are virtually identical to the Danish studies, despite the difference in exposure to thimerosal.

Next, we consider the alternative explanation for our findings; namely, that there has not been a true increase but that other factors account for the apparent increase in the incidence of autism. To study potential antecedents of change in the rate of occurrence of autism, it is necessary to examine changes in incidence across time.[31] We were particularly interested in determining whether there was a change in incidence following the introduction of broader, more precise diagnostic criteria, increased availability of services, and increased awareness of autism. In our study, incidence was relatively stable from 1980 to 1987, after which it increased from 7.9 to 44.9 per 100 000 children. The timing of this increase is coincident with the publication of the *DSM-III-R*, which introduced the concept of a broader autism spectrum and provided formal diagnostic criteria.[28] In 1994, the *DSM-IV* further broadened the autism spectrum.[1] Federal special education laws first included autism spectrum disorder as a disability category in 1991.[32] Thus, the increase in the incidence of autism coincided with the publication of broader, less restrictive diagnostic criteria, increased availability of special education services, and increased awareness of autism.

We found that age-specific incidence rates were stable from 1976 to 1997 for children aged 10 to 21 years; however, after 1988 to 1991, rates increased for children younger than 10 years. Cohort-specific incidence rates were much higher for children born after 1987. This increased incidence in younger children occurred after publication of the *DSM-III-R* and continued after the 1991 revision of the special education laws and the 1994 publication of the *DSM-IV*.[1,28,32] This effect was seen primarily for the cohorts born after 1987, who would have begun to manifest symptoms of autism in 1989 and beyond. Diagnostic assessments for developmental diabilities, including autism, are typically completed before children reach age 10 years. Therefore, the impact of the new diagnostic criteria and increased awareness of autism would not be expected in older age groups.

If our finding of low incidence in the early years of this study was due to a failure to identify less severely affected children during those early years, we might also have found that the early cases were more severely affected than those from later years. Although we did not find any differences in the number of autism symptoms or cognitive profile of cases across time, the number of documented symptoms is not necessarily indicative of symptom severity; hence, we were not able to make meaningful comparisons of severity among our cases across time.

If awareness of developmental disorders and availability of services affected the extent to which children with autism were evaluated and had symptoms documented in their records, this phenomenon should also be observed for other developmental disorders. In fact, the incidence of other developmental disorders increased between 1976 and 1997 (1.8-fold). The first federal special education laws in 1975 preceded the increase in the identification of children with any

developmental disorder, including autism.[32] Subsequent to this legislation, families and health care professionals had a valid reason to bring children with developmental disorders to medical attention; namely, to obtain a formal diagnosis that would allow the child to receive appropriate special education services. In contrast to the steady increase in the incidence of other developmental disorders from 1976 to 1997, the incidence of research-identified autism was steady until 1988 to 1991, increasing thereafter. The publication of the *DSM-III-R* in 1987 and the amendments to the special education laws in 1991 preceded this change.[28,32]

Several potential limitations of this research should be noted. We did not directly assess our subjects, so we could not directly verify the symptoms abstracted from medical and school records. However, our study design enabled us to apply *DSM-IV* criteria to every child, regardless of the year in which the child was seen clinically. We examined the records of all 3109 children who had ever received a clinical diagnosis of any developmental, neurologic, or psychiatric diagnosis during the time frame of this study. However, the broad list of clinical diagnoses used in the initial phase of the study, the completeness of the data from 1976 to 1997, and the availability of records for virtually all residents of Olmsted County minimize the possibility that autism cases were missed. Autism incident cases were identified among both children who were residents of Olmsted County at birth and those who were not residents at birth. Nevertheless, all incident cases had to be residents of Olmsted County when research criteria were fulfilled. There is no reason to believe that the increase in incidence from the period between 1988 and 1991 to 1992 and 1994 was due to a sudden influx of children with autism into Olmsted County. In fact, the overall change in incidence from the period between 1988 and 1991 to 1992 and 1994 (11.8 to 29.4 per 100 000 people, 2.5-fold increase) was similar in relative magnitude to the change in incidence if incident cases had included only children who were residents of Olmsted County at birth (6.9 to 20.7 per 100 000 people, 3.0-fold increase). Also, the median age at which the first symptom of autism was documented was comparable for children who were residents of Olmsted County at birth (2.4 years) and those who were not (3.0 years). Finally, the racial demographics of our population suggest caution in generalizing our findings. Nevertheless, a recent study[5] demonstrated that the prevalence of autism is comparable for black and white children.

This study shows an increase in the incidence of research-identified autism among children in Olmsted County, Minnesota, from 1976 to 1997. We cannot exclude the possibility that environmental factors caused this increase; additional studies are needed to address this possibility. The MMR vaccine was introduced in Minnesota almost 20 years before the increase in the incidence of autism, suggesting that the MMR vaccine did not contribute to this phenomenon. The timing of the change in autism incidence in Olmsted County is coincident with the introduction of broader diagnostic criteria, increased availability of education services, and increased awareness of autism.

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