

LONG-TERM INTELLECTUAL AND BEHAVIORAL OUTCOMES OF CHILDREN WITH FEBRILE CONVULSIONS

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ABSTRACT

Background Hospital-based studies have reported that children with febrile convulsions have subsequent mental retardation and behavior problems. In contrast, population-based studies have reported a better outcome.

Methods We identified 398 children with febrile convulsions among 14,676 children enrolled in the Child Health and Education Study, a national population-based study in the United Kingdom of children born in one week in April 1970. The children were comprehensively assessed at the age of 10. After excluding 16 children who had neurodevelopmental problems before their first febrile convulsion and 1 child whose case was atypical, we studied 381 children, 287 with simple febrile convulsions and 94 with complex febrile convulsions. We compared them with the rest of the cohort using measures of academic progress, intelligence, and behavior that included questionnaires, standardized tests, and formal tests.

Results At the 10-year assessment, only 4 of 102 measures of academic progress, intelligence, and behavior differed significantly between the entire group of children with febrile convulsions and the group without febrile convulsions — no more than would be expected by chance. Similar results were found when children with simple febrile convulsions and those with complex febrile convulsions were analyzed separately. The children with recurrent episodes of febrile convulsions had outcomes similar to those of the children with only one episode each. Special schooling was required for more children who had febrile convulsions in the first year of life than for those who had had them later in life (5 of 67, or 7.5 percent, vs. 4 of 265, or 1.5 percent; $P=0.02$), but these numbers were small.

Conclusions Children who had febrile convulsions performed as well as other children in terms of their academic progress, intellect, and behavior at 10 years of age. (N Engl J Med 1998;338:1723-8.)

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MANY parents think that their child is dying when he or she has a febrile convulsion,¹ and they are concerned that epilepsy or mental retardation may result. Febrile convulsions are common, occurring in 2 to 4 percent of children at least once before five years of age.^{2,3} Mental retardation has been reported in up to 22 percent of children with febrile convulsions who were hospitalized or seen in specialized clinics.⁴⁻⁶ In contrast, the National Collaborative Per-

inatal Project, a large, prospective American study that enrolled approximately 54,000 pregnant women between 1959 and 1966 and followed their children, found that children who had febrile convulsions did not differ in intelligence from their normal seizure-free siblings at seven years of age.⁷

A prospective British study, the Child Health and Education Study, enrolled a cohort of over 16,000 children born in one week in April 1970. We have previously reported on the outcome at five years of the children in the cohort who had febrile convulsions.^{8,9} At the age of 10, the children underwent a more comprehensive assessment of intellect and behavior. We report the results of this assessment in this article.

METHODS**Subjects**

The Child Health and Education Study (initially called the British Births Survey)¹⁰ enrolled about 98 percent of the infants born in the United Kingdom in one week in April 1970. The cohort consisted of 16,163 infants who survived the neonatal period (the first 28 days of life), resulting from 16,004 pregnancies. At 5 and 10 years of age the children were followed up with the use of questionnaires filled out by the children and their mothers, hospital records, and assessments by teachers, health visitors (community care nurses), and school doctors. The mothers' questionnaire included the following question: "Has the child ever had any form of convulsion, fit, seizure, or any other turn in which consciousness was lost or any part of the body made an abnormal movement?" Information was available for 14,676 children, of whom 1318 were thought to have had seizures on the basis of answers to the questionnaire. These results were confirmed by questionnaires sent to general practitioners (92 percent of which were returned) and by obtaining hospital records for 89 percent of the children who were treated at or admitted to a hospital.

The study was approved by the British Medical Association, the Department of Health and Social Security, the Health Visitors' Association, the Medical Research Council, and the National Birthday Trust Fund.

Definition of Febrile Convulsions

A febrile convulsion was defined as an event in infancy or childhood, usually occurring between three months and five years of age, associated with fever but without evidence of intracranial infection or a defined cause. This definition was developed at a 1980 consensus conference at the National Institutes of Health.¹¹ Measurement of fever was not mandatory. Seizures in the first four weeks of life were not included. Convulsions that occurred during fevers after vaccination were included. Children who had

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had seizures that were not associated with fever were included in the control group. A complex febrile convulsion was defined as a convulsion that lasted longer than 15 minutes, that was focal, or that occurred more than once during an episode of fever, in accordance with the criteria of the National Collaborative Perinatal Project.¹² All other febrile convulsions were classified as simple. Febrile convulsions lasting longer than 30 minutes were classified as lengthy.

Using information from the mothers' questionnaires, general practitioners' questionnaires, and children's hospital records at both 5 and 10 years of age, a pediatric neurologist judged that 398 children (220 boys and 178 girls) had had at least one febrile convulsion (median age at first febrile convulsion, 19 months; range, 2 months to 7 years 9 months). Sixteen children who had evidence of neurologic or developmental abnormality before the first febrile convulsion were excluded. One other child was excluded because his care probably contributed to a poor outcome: his parents had inadvertently caused severe hyperpyrexia by putting him in a hot bath during a convulsion. Thus, 381 children with febrile convulsions were assessed (212 boys and 169 girls).

10-Year Assessment

The 10-year assessment was performed on all children in the cohort who were available. The questionnaires included items requiring categorical answers and non-categorical measures (visual-analogue scores and standardized scores): some items were based on the behavioral questionnaires devised by Rutter et al.¹³ and the Conners behavioral rating scales.¹⁴ Some of the formal tests were already in general use, and others were standardized for the study.¹⁵

We chose 102 measures to assess outcome after febrile convulsions. The local education authority provided information about intellectual ability (1 measure) and the need for special schooling (1 measure). The mothers' questionnaire provided information on academic progress, speech and language development, the frequency of temper tantrums, attention span, motor coordination, and life skills (52 measures). The children's questionnaire comprised questions related to school progress and self-esteem (11 measures). The teachers' questionnaire included a question about enuresis or encopresis (1 measure). Intelligence was assessed with the British Ability Scales,¹⁶ which yielded a full-scale IQ, a verbal IQ, and a nonverbal IQ; four subscales were also used (7 measures in all). Academic progress was evaluated with tests standardized for the study: the Picture Language Test, the Friendly Maths Test, reading tests, assessment of socialization, a language assessment, and composite scores derived from the British Ability Scales (21 measures). Composite behavior scores were derived from the mothers' questionnaire and teachers' questionnaire (8 measures).

The children were also classified according to whether they had had simple febrile convulsions or complex febrile convulsions. Thus, we compared the group of children with febrile convulsions as a whole and these two subgroups with the rest of the cohort (the control group), which potentially numbered over 14,000. Not all the children completed all the follow-up assessments, so the numbers evaluated varied according to the outcome measure. Some children who enrolled in special schools because of difficulties with learning were not assessed.

Statistical Analysis

The study of febrile convulsions was a small part of the research focused on this large cohort. Because of difficulty in obtaining funding, the statistical analyses of the 10-year follow-up data were not completed until 1997. Subjects were not followed after the age of 10.

All statistical tests were two-tailed, and P values of less than 0.05 were considered to indicate statistical significance. Categorical outcome variables were compared with the chi-square test. When the numbers of subjects were very small, Fisher's exact test¹⁷ was used in two-by-two tables. Non-categorical variables were compared with the Mann-Whitney test.¹⁸

RESULTS

The study included 381 children with febrile convulsions: 287 had simple febrile convulsions, and 94 had complex convulsions. By the age of 10 the children had been free of febrile convulsions for at least 2 years. Mean maternal and paternal ages at the time of the 10-year assessment were similar in the groups with febrile convulsions and the control group (Table 1). There were no significant differences between the groups in terms of the parents' social class or level of education, housing (extent of crowding and type of neighborhood), or race or ethnic background (data not shown). The proportions of children in the group with febrile convulsions who had educational difficulties or who were receiving or being considered for special schooling were not significantly different from those in the control group (Table 2).

The outcome measures provided a comprehensive assessment of academic progress, intelligence, and behavior. Only 4 of 102 measures were significantly different between the entire group of children with febrile convulsions and the control group — this was no more than expected by chance. On the mothers' questionnaire, the children with febrile convulsions were rated as more impulsive or excitable than the control children (mean score, 35 vs. 31; $P=0.04$). On the children's questionnaire, 2.6 percent of those who reported that they did not do well in gymnastics had had febrile convulsions, as compared with 2.0 percent of those who reported that they did well ($P=0.04$). The composite behavior scores derived from the mothers' questionnaire indicated that the children with febrile convulsions were more anxious than the control children (mean score, $+0.16$ vs. $+0.01$; $P=0.01$) (Table 3). The children with febrile convulsions had better reading skills than the control children, as measured on the basis of a standardized score derived from the British Ability Scales (mean score, $+1.08$ vs. -0.48 ; $P=0.02$). With the exception of these four differences, the children with febrile convulsions were in general similar to the controls. The results were similar when the subgroups of children who had simple febrile convulsions and complex febrile convulsions were analyzed separately (data not shown).

The battery of outcome measures included standardized tests of intellectual ability, and the results of some of the principal tests are shown in Table 4. For all three groups with febrile convulsions, the scores on the British Ability Scales (total, verbal, and nonverbal), the Picture Language Test, and the Friendly Maths Test were similar to those of the controls.

We also assessed two other subgroups of children — those who had had febrile convulsions in the first year of life and those who had had recurrent episodes — using the information about educational

TABLE 1. AGES OF THE PARENTS OF THE CHILDREN WITH FEBRILE CONVULSIONS AND THE CONTROL CHILDREN AT THE TIME OF THE 10-YEAR ASSESSMENT.*

VARIABLE	ALL CHILDREN WITH FEBRILE CONVULSIONS	CHILDREN WITH SIMPLE FEBRILE CONVULSIONS	CHILDREN WITH COMPLEX FEBRILE CONVULSIONS	CONTROL CHILDREN
Mothers				
No. of women	332	248	84	12,981
Age (yr)	36±6	37±5	36±6	36±6
P value	0.90	0.65	0.31	
Fathers				
No. of men	307	230	77	12,108
Age (yr)	39±6	39±6	39±7	39±7
P value	0.71	0.74	0.86	

*Plus-minus values are means ±SD. The P values are for the comparison with the control group.

TABLE 2. INTELLECTUAL ABILITY AND NEED FOR SPECIAL SCHOOLING AS DETERMINED BY THE LOCAL EDUCATION AUTHORITY.

VARIABLE	ALL CHILDREN WITH FEBRILE CONVULSIONS	CHILDREN WITH SIMPLE FEBRILE CONVULSIONS	CHILDREN WITH COMPLEX FEBRILE CONVULSIONS	CONTROL CHILDREN
	number (percent)			
Intellectual ability				
No. evaluated	334	249	85	13,009
Normal intellectual ability	305 (91.3)	226 (90.8)	79 (92.9)	12,017 (92.4)
Severely subnormal intellectual ability (IQ, <50)	1 (0.3)	1 (0.4)	0	39 (0.3)
Mildly subnormal intellectual ability (IQ, 50 to 70)	3 (0.9)	3 (1.2)	0	142 (1.1)
Problems with reading	14 (4.2)	9 (3.6)	5 (5.9)	382 (2.9)
Other educational problems	11 (3.3)	10 (4.0)	1 (1.2)	429 (3.3)
P value*	0.56	0.57	0.35	
Special education				
No. evaluated	332	248	84	12,950
No	323 (97.3)	241 (97.2)	82 (97.6)	12,615 (97.4)
Yes (or likely)	9 (2.7)	7 (2.8)	2 (2.4)	335 (2.6)
P value*	0.88	0.82	0.63	

*The P values are for the comparison with the control group.

requirements obtained from the local health authority and 20 tests of intellectual ability: the British Ability Scales or scores derived from them (12 measures), reading tests (6 measures), the Picture Language Test (1 measure), and the Friendly Maths Test (1 measure). Of the 80 children who had febrile convulsions before the age of one, information about educational needs was available for 67. Five (7.5 percent) were receiving or were being considered for special education — a significantly greater proportion than in the group who had convulsions when older than one year (4 of 265, or 1.5 percent; $P=0.02$). Intellectual ability was assessed at 10 years of age in 54 of the children who had febrile convulsions in the first year of life, and there were no measures on which they performed significantly less well

than the children who had febrile convulsions when older than one year.

The children who had had more than one episode of febrile convulsions were compared with those who had had only one episode in the group as a whole and in the groups with simple and complex febrile convulsions. Children with recurrent episodes were no more likely to need special schooling than those who had had only one episode. When the results of all three groups were combined (three sets of 20 tests), there was only one significant difference — no more than expected by chance. Children who had had more than one episode of simple febrile convulsions had better reading skills, as measured on the basis of a standardized score derived from the British Ability Scales, than those who had had only

TABLE 3. COMPOSITE BEHAVIOR SCORES OF THE CHILDREN AS REPORTED BY THEIR MOTHERS AND TEACHERS.*

VARIABLE	ALL CHILDREN WITH FEBRILE CONVULSIONS	CHILDREN WITH SIMPLE FEBRILE CONVULSIONS	CHILDREN WITH COMPLEX FEBRILE CONVULSIONS	CONTROL CHILDREN
Mothers' questionnaire				
No. evaluated	334	249	85	13,295
Antisocial behavior	+0.01±0.98	+0.03±1.02	-0.05±0.86	+0.03±1.01
Hyperactivity	+0.03±1.01	+0.06±1.03	-0.05±0.96	+0.02±1.01
Clumsiness	0.00±1.07	0.00±1.04	+0.01±1.14	0.00±1.00
Anxiety	+0.16±1.03†	+0.14±1.04‡	+0.20±1.00	+0.01±1.01
Teachers' questionnaire				
No. evaluated	297	227	70	12,401
Antisocial behavior	+0.01±1.04	+0.08±1.09	-0.23±0.85	-0.03±0.99
Inattentiveness	-0.02±0.97	0.00±0.97	-0.08±1.00	0.00±0.99
Clumsiness	0.00±1.02	+0.02±1.00	-0.08±1.08	-0.01±1.00
Anxiety	+0.07±0.95	+0.06±0.97	+0.12±0.87	-0.03±0.98

*Plus-minus values are means ±SD. The scores were derived from the mothers' and teachers' replies to items on questionnaires. They were combined and standardized so that the mean score for each of the measures in the control group was approximately 0.0±1.0. Defining the normal score as the mean ±2 SD gives a normal range of -2 to +2. Higher scores indicate more abnormal behavior.

†P=0.01 for the comparison with the control group.

‡P=0.04 for the comparison with the control group.

TABLE 4. INTELLECTUAL ABILITY AT 10 YEARS OF AGE ACCORDING TO STANDARDIZED TESTS.*

TEST	ALL CHILDREN WITH FEBRILE CONVULSIONS	CHILDREN WITH SIMPLE FEBRILE CONVULSIONS	CHILDREN WITH COMPLEX FEBRILE CONVULSIONS	CONTROL CHILDREN
British Ability Scales				
Total score				
No. evaluated	294	223	71	12,915
Mean score	101±15	101±15	99±14	100±15
Nonverbal score				
No. evaluated	294	223	71	12,277
Mean score	99±15	100±15	98±13	100±15
Verbal score				
No. evaluated	296	225	71	12,280
Mean score	101±15	102±15	100±15	100±15
Picture Language Test				
No. evaluated	298	227	71	12,462
Mean score	100±15	100±15	98±13	100±15
Friendly Maths Test				
No. evaluated	298	227	71	12,432
Mean score	101±15	101±15	100±14	100±15

*Plus-minus values are means ±SD. The normal mean score on the tests was 100±15. Defining the normal as the mean value ±2 SD gives a normal range of 70 to 130. The higher the score, the better the performance. There were no significant differences between the groups.

one episode (mean score, 3.85 vs. 0.31, P=0.04). When we used the 20 measures of intellectual outcome to compare, in the group as a whole, children who had had three or more episodes of febrile convulsions with those who had had fewer than three episodes, we found no significant differences between them. There were also no significant differences between boys and girls in terms of the propor-

tion who had educational problems or who needed special schooling by 10 years of age.

DISCUSSION

In general, hospital-based studies select the patients with more severe cases, whereas prospective population-based studies try to identify all affected persons. Only a few large, prospective studies of

childhood seizures have been performed,^{7,9,12,19-23} and only one of these, the National Collaborative Perinatal Project,⁷ has objectively evaluated intellectual outcome after febrile convulsions.

The strengths of our study are that it was prospective and the children with febrile convulsions were therefore not a selected group. Clinical information for almost all the children with suspected seizures was obtained from general practitioners and hospital records. We therefore think that there were few incorrect diagnoses (false positive results) in the group with febrile convulsions. Any children with febrile convulsions who were not identified would have remained in the control group as a very small proportion of that group and would have been unlikely to influence the results.

Inevitably, some children were lost to follow-up. A particular concern was that children in special schools might not be tested and that this would bias the results. However, the proportion of children who needed special education was the same in the groups with febrile convulsions as in the control group.

Some hospital-based studies have found relatively high rates of mental retardation at follow-up among children with febrile convulsions.⁴⁻⁶ In a study of 14 pairs of monozygous twins who were discordant for febrile convulsions, there were significant intellectual impairments in those who had had febrile convulsions.²⁴ We found that groups of children with simple and complex febrile convulsions did not differ from the control group in terms of their academic progress or intellectual abilities. The number of outcome measures that were significantly different between the groups was no more than would be expected by chance. We concluded that there was no evidence that any of these differences was clinically or practically important.

Specific learning difficulties have been reported in children who have had febrile convulsions. These include problems with drawing⁶ and arithmetic²⁴ and a delay in speech development.²⁵ We found little evidence of such difficulties.

Behavior disorders and attention deficits have also been found after febrile convulsions.^{3,24-27} In our study, the mothers' questionnaire revealed no increase in temper tantrums after febrile convulsions. Composite behavior scores showed that mothers rated the children with febrile convulsions as more anxious than control children, but there were otherwise no significant differences between groups with respect to inattentiveness, hyperactivity, clumsiness, or antisocial behavior.

In one study, the incidence of neurologic sequelae and mental retardation was higher when the first febrile convulsion occurred at an early age.⁵ We found that a greater proportion of children with febrile convulsions in the first year of life were receiving or being considered for special education, but the num-

ber was small. When assessed at 10 years of age, such children performed as well as those who had had febrile convulsions when older than 1 year of age.

Another study²⁸ found that one or more recurrent febrile convulsions were more likely to be detrimental to intellectual development than continuous prophylactic treatment with either phenobarbital or sodium valproate. However, the National Collaborative Perinatal Project found that in children who had normal intellect before their first febrile convulsion, there was no association between recurrent febrile convulsions and a subsequent IQ deficit.⁷ We found no evidence of a worse outcome among the children with recurrent episodes of febrile convulsions, even when we studied those who had had three or more episodes.

In a discussion of therapy for febrile convulsions, Camfield and Camfield wrote: "The best treatment for children with a first febrile seizure is education and reassurance for their parents."²⁹ That opinion is reinforced by our results, which showed that children with febrile convulsions did not differ from the other children in the cohort in their intellectual and behavioral outcome, even if they had had recurrent episodes.

We previously reported that children with complex febrile convulsions were at greater risk for afebrile seizures by 10 years of age than children with simple febrile convulsions.²¹ In the current study, we found that the intellectual and behavioral outcome of the group with complex febrile convulsions was as good as that of the rest of the cohort. Our data should reassure both parents and physicians that the outlook is good for most children who have febrile convulsions.

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