# Maternal depression increases infant risk of diarrhoeal illness: –a cohort study

A Rahman, J Bunn, H Lovel and F Creed

*Arch. Dis. Child.* 2007;92;24-28; originally published online 11 Sep 2006;
doi:10.1136/adc.2005.086579

ORIGINAL ARTICLE

# Maternal depression increases infant risk of diarrhoeal illness: –a cohort study

**A Rahman, J Bunn, H Lovel, F Creed**

*Arch Dis Child* 2007;**92**:24–28. doi: 10.1136/adc.2005.086579

See end of article for authors' affiliations

Correspondence to: Dr A Rahman, Division of Psychiatry, School of Psychiatry and Behavioural Sciences, University of Manchester, Rawnsley Building, Oxford Road, Manchester M13 9WL, UK; atif.rahman@ntlworld.com

Accepted 29 August 2006
**Published Online First 6 September 2006**

**Aims:** To examine the associations between postnatal depression in mothers and diarrhoeal illness in their infants in the first year of life in a low-income country.
**Methods:** Using a prospective cohort design, 265 infants (n = 130 of mothers having a depressive episode according to the *International Classification of Diseases*, 10th revision, at 3 months postnatal and n = 135 of psychologically well mothers) living in rural Rawalpindi, Pakistan, were followed up for 1 year. Frequency of diarrhoeal episodes was measured fortnightly by health workers using a standard questionnaire.
**Results:** Infants of depressed mothers had significantly more diarrhoeal episodes per year than those of controls (mean 5.5 *v* 4.0; 95% confidence interval (CI) 0.9 to 2.0). The relative risk of having ⩾5 diarrhoeal episodes per year in infants of depressed mothers was 2.3 (95% CI 1.6 to 3.1). The association remained significant after adjustment for other risk factors by multivariate analysis.
**Conclusions:** Maternal depression is associated with infant diarrhoeal morbidity in a low-income community setting. It is independent of the effects of known factors such as undernutrition, socioeconomic status and parental education. Preventive child health programmes targeting mothers must consider their mental health.

In low-income developing countries, diarrhoea is a major public health problem. Annually, it kills about 2.2 million people, most of whom are infants or young children.[1] Each year, there are approximately 4 billion cases of diarrhoea worldwide. Diarrhoea can be prevented by drinking boiled water, improving household sanitation, and ensuring personal and food hygiene. Key measures to treat diarrhoea include oral rehydration and continued feeding. During infancy, these actions require the primary care giver, usually the mother, to be active, alert and fully responsive to the usually hostile environment in a poor community.

Studies from south Asian countries have shown that about 25% of women have depression around the period of childbirth.[2 3] Depression is a disabling disorder. Symptoms include low mood, lack of energy, poor concentration, amotivation and a lack of interest in the environment. In a previous study in rural Rawalpindi, Pakistan, we showed that antenatal depression was associated with low birth weight and poor growth in the first year of life.[4] However, it was not clear whether the increased rates of diarrhoeal infection, also observed in infants of these mothers, were a result of undernutrition or were independently associated with maternal depression that continued beyond the antenatal period.

To explore this, we re-examined data from our original study. Our hypothesis was that maternal depression at 3 months postnatal is associated with increased diarrhoeal morbidity during infancy, and this is independent of the effects of low birth weight, infant nutritional status, duration of breast feeding and socioeconomic situation.

## METHODS

### Participants and assessments

The detailed method is reported previously.[4] Briefly (fig 1), all married women aged 17–40 years in the third trimester of pregnancy registered with local health workers (n = 701) were approached in 10 Union Councils (each consisting of 5–10 villages; total population 150 000) of a sub-district of Rawalpindi. We assessed 670 women (mean 6 weeks from delivery date), using the Schedules for Clinical Assessment in Neuropsychiatry, developed by the World Health Organization as an internationally validated semistructured interview generating diagnoses of depressive episode according to the *International Classification of Diseases*, 10th revision.[5] All interviews were carried out by two trained and experienced clinicians. Women were excluded if they had a physical illness for which they were receiving treatment or a complication during pregnancy. Of the 632 women who met these criteria, 160 were diagnosed with depressive episodes, giving a prevalence rate of 25% of depressive disorders in the antenatal period. Each depressed woman was matched with a psychologically well woman of similar gestation residing in the same Union Council, producing a cohort of 320 women with a 1:1 ratio of depressed to non-depressed women. The cohort was reassessed at 3 months. Nine mothers from the non-depressed group became depressed, whereas eight depressed mothers recovered. After accounting for attrition due to various reasons (fig 1), we were left with our index group of 144 depressed and 146 non-depressed mothers. Of these, 265 (130 depressed and 135 non-depressed) mothers completed the 1-year follow-up.

The infants of both groups of mothers were prospectively assessed fortnightly for a year by the local lady health workers. Each lady health worker covers 1000 people (about 130 households), visiting about 30–35 houses every week. They were trained to use a specially designed questionnaire to record the number of episodes of diarrhoea in the previous 2 weeks. Diarrhoea was defined as having ⩾3 unformed stools passed in a 24-h period, and a ''diarrhoeal episode'' was defined as being separated from another episode by at least three diarrhoea-free days.[6] Mothers were also given a special diary in which to record the days in which the child remained ill. To minimise recall bias, the mother's report in the previous 2 weeks was corroborated from another member of the household such as the grandmother, husband or an older sibling. The average infant in Pakistan may experience 5–12 episodes of diarrhoea per year.[7] On the basis of these figures, data for diarrhoeal episodes were categorised dichomotomously using a cut-off of ⩾5 episodes. Table 1 lists the variables on which data were collected.

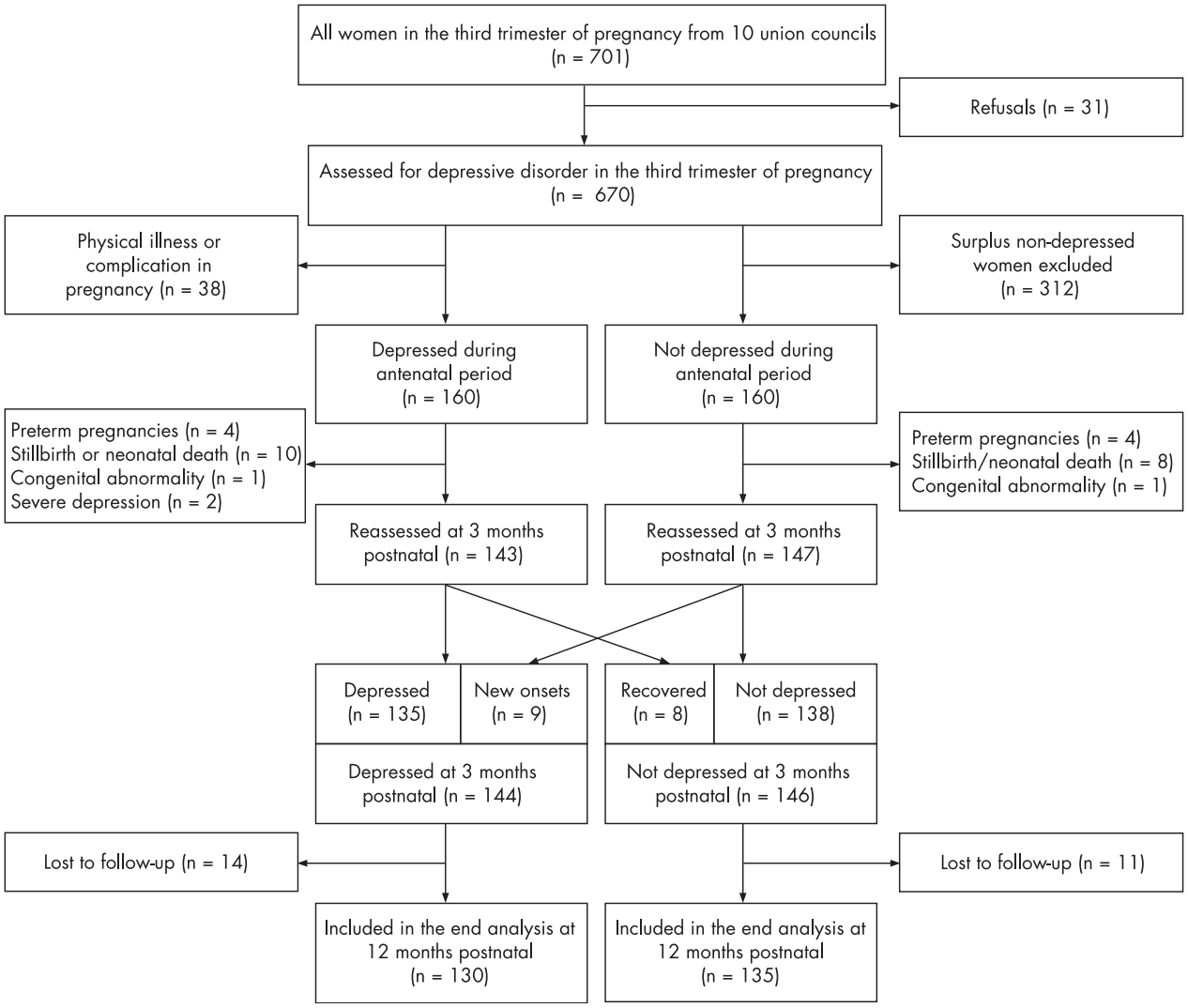


**Figure 1** Sampling profile.

**Table 1** Unadjusted relative risk of ⩾5 diarrhoeal episodes per year with postnatal depression in mothers and other risk factors during infancy

| Risk or protective factor | n (%) <5 (n = 153) | n (%) ⩾5 (n = 112) | Relative risk (95% CI) | p Value |
|---|---|---|---|---|
| Postnatal depression | 53 (35) | 77 (68) | 2.3 (1.6 to 3.1) | <0.01 |
| Mother's age ⩾30 years | 48 (31) | 37 (33) | 1.1 (0.7 to 1.4) | 0.7 |
| Mother's BMI <18.5 kg/m$^2$ | 23 (15) | 25 (22) | 1.3 (0.9 to 1.7) | 0.1 |
| Not breast feeding at 6 months | 15 (9) | 19 (17) | 1.4 (0.9 to 1.9) | 0.09 |
| Mother had no formal schooling | 59 (38) | 56 (30) | 1.3 (0.9 to 1.7) | 0.07 |
| Father had no formal schooling | 20 (13) | 25 (22) | 1.4 (1.03 to 1.9) | 0.06 |
| Empowerment (mother has some control over finances) | 78 (51) | 47 (42) | 0.8 (0.6 to 1.0) | 0.1 |
| Family in debt | 60 (39) | 58 (52) | 1.3 (1.01 to 1.7) | <0.05 |
| Living in a nuclear family | 39 (25) | 43 (38) | 0.7 (0.5 to 0.9) | <0.05 |
| ⩾4 siblings | 59 (38) | 54 (48) | 1.2 (0.9 to 1.6) | 0.1 |
| Female sex of the infant | 76 (49) | 56 (50) | 1.0 (0.7 to 1.3) | 1.0 |
| Low birth weight (⩽2500 g) | 30 (19) | 36 (32) | 1.4 (1.1 to 1.9) | <0.05 |
| WAZ <−2SD at 6 months | 15 (10) | 33 (29) | 1.8 (1.4 to 2.4) | <0.01 |

BMI, body mass index; WAZ, weight-for-age z score.

### Statistical analysis

Preliminary analyses consisted of descriptive frequencies and the $\chi^2$ and Mann–Whitney U tests to compare differences between depressed and non-depressed mothers in household assets, delivery care and personal characteristics. The mean differences in the number of diarrhoeal episodes between the exposed (infants of antenatally depressed mothers) and non-exposed (infants of antenatally non-depressed mothers) group were analysed using the t-test. Univariate analyses were then carried out to estimate relative risks with 95% confidence interval (CI) of having ⩾5 episodes. Multiple logistic regression was used to simultaneously control for the confounding effects of all the variables under study and obtain an odds ratio as the measure of association. All analyses were carried out with STATA V.7.[8]

### Sample size

Assuming a rate of infant diarrhoea at 6 events per year (0.5 events/month),[7] we estimated that the study would require 144 infants in each group to be followed up for 1 year to detect a 20% increase in diarrhoeal events in the exposed group compared with the controls, with a power of 80% and 95% CI.

The ethics committees of Rawalpindi Medical College, Rawalpindi, Pakistan and the University of Manchester, Manchester, UK, approved the study.

## RESULTS

Table 2 compares households with depressed and non-depressed mothers regarding possession of household assets, source of water supply, type of latrine facility, type of obstetric care received and sociodemographic factors. We found no significant difference between the two groups on any of the factors measured.

Infants of depressed mothers had significantly more episodes of diarrhoea per year than controls (mean 5.5 *v* 4.0; 95% CI 0.9 to 2.0, p<0.01). Of 265 infants, 112 (42%) had ⩾5 diarrhoeal episodes per year. Univariate analysis (relative risk, Fisher's two-sided exact p) between ⩾5 diarrhoeal episodes per year and individual risk factors showed a significant positive association with maternal postnatal depression, family in debt, living in a nuclear family, low birth weight and a weight-for-age z score of <−2 standard deviations (SDs) at age 6 months, and a trend towards a positive association with not breast feeding at 6 months and parents being uneducated. None of the other factors showed an association (table 1).

Multiple logistic regression (table 3) showed that after simultaneous adjustment for all risk factors, the association between postnatal depression and ⩾5 infant diarrhoeal episodes per year remained significant. The only other significant positive association was with the weight-for-age z score of <−2 SDs at age 6 months, whereas association with all other risk factors was not statistically significant.

## DISCUSSION

To our knowledge, this is the first study showing an association between postnatal depression and infant diarrhoeal morbidity in a low-income developing country. We did not rely solely on mothers' reporting as this may have biased our findings—data were verified from other close members of the family. The exposure status—that is, maternal depression—was determined in the antenatal period and reassessed 3 months postnatally by experienced clinicians using a standardised interview.

However, the findings should be generalised with caution as the study was carried out in only one subdistrict of Rawalpindi. Although potential confounders were carefully adjusted for in the analysis, it is possible that an unmeasured sociocultural or environmental factor peculiar to the study area might account for the association observed.

Our study did not examine the process by which maternal depression led to higher rates of diarrhoeal infection in infants. Such associations are presumably the result of complex causal

**Table 2** Comparison of depressed and non-depressed groups with respect to household assets, source of water supply, type of latrine facility, type of obstetric care and sociodemographic characteristics

| | Depressed (n = 130) | Not depressed (n = 135) | $\chi^{2*}$ | p Value |
|---|---|---|---|---|
| Household assets | | | | |
| Electricity | 129 (99) | 132 (98) | 0.940 | 0.3 |
| Television | 48 (37) | 61 (45) | 1.867 | 0.1 |
| Refrigerator | 14 (11) | 18 (13) | 0.410 | 0.5 |
| Bicycle | 19 (14) | 13 (10) | 1.550 | 0.2 |
| Working on own or family's agricultural land | 54 (41) | 51 (38) | 0.391 | 0.5 |
| Source of water supply | | | | |
| Well without electric pump | 87 (67) | 91 (67) | 0.007 | 0.9 |
| Well with electric pump | 31 (24) | 36 (27) | 0.278 | 0.6 |
| Public tap or piped on to property | 12 (9) | 8 (6) | 1.036 | 0.3 |
| Type of latrine facility | | | | |
| Toilet with flush | 58 (44) | 61 (45) | 0.008 | 0.9 |
| Field or bush | 69 (53) | 71 (52) | 0.006 | 0.9 |
| Bucket | 3 (2) | 3 (2) | 0.002 | 0.9 |
| Delivery care | | | | |
| Birth attended by a family member | 72 (55) | 76 (56) | 0.223 | 0.8 |
| Birth attended by a traditional birth attendant | 27 (20) | 24 (18) | 0.582 | 0.4 |
| Birth attended by medically trained personnel | 33 (25) | 33 (24) | 0.061 | 0.8 |
| Sociodemographic | | | | |
| Mothers employed outside home | 3 (2) | 8 (6) | 2.139 | 0.1 |
| Mothers with no formal education | 61 (47) | 54 (40) | 1.292 | 0.2 |
| Mothers' age (years) | 26 (24–30) | 26 (24–30) | −1.606 | 0.1 |

*Mann–Whitney U in case of median.
Values are n (%) or median (IQR).

**Table 3** Estimates of simultaneous effects of postnatal depression and other risk factors on diarrhoeal morbidity in 265 infants through multiple logistic regression

| | ⩾5 Diarrhoeal episodes/year (n = 112) | |
|---|---|---|
| **Risk factor** | **OR (95% CI)** | **p Value** |
| Postnatal depression | 3.1 (1.8 to 5.6) | <0.01 |
| Mother's age ⩾30 years | 0.7 (0.3 to 1.4) | 0.3 |
| Mother's BMI <18.5 kg/m$^2$ | 1.5 (0.7 to 3.2) | 0.2 |
| Not breast feeding at 6 months | 1.7 (0.7 to 4.1) | 0.1 |
| Mother had no formal schooling | 1.4 (0.7 to 2.6) | 0.2 |
| Father had no formal schooling | 1.3 (0.6 to 2.7) | 0.4 |
| Empowerment (mother has some control over finances) | 1.0 (0.5 to 1.8) | 0.9 |
| Family in debt | 0.9 (0.5 to 1.7) | 0.9 |
| Living in a nuclear family | 1.5 (0.8 to 2.9) | 0.1 |
| ⩾4 siblings | 1.4 (0.7 to 2.7) | 0.2 |
| Female sex of the infant | 0.9 (0.5 to 1.7) | 0.8 |
| Low birth weight (⩽2500 g) | 1.5 (0.8 to 2.9) | 0.1 |
| WAZ <−2SD at 6 months | 2.5 (1.2 to 5.4) | 0.01 |

BMI, body mass index; WAZ, weight-for-age z score.

chains, and there may be different ways in which risk factors work together to influence the outcome. Factors such as parental education, social support, socioeconomic status and infant nutritional status might be important moderators in the association. Similarly, factors such as quality of infant care and feeding practice could mediate the effects of depression on diarrhoeal morbidity. Further studies in different settings and with larger sample sizes would be required to clarify the nature of these interactions.

Nevertheless, depression is clearly a disabling disorder. Patel *et al*[3] found that in India postnatally depressed mothers scored significantly higher on the Brief Disability Questionnaire (an 8-item questionnaire that rates current problems in carrying out daily activities), spending about twice the number of days in the previous 30 days unable to complete their daily activities. It is plausible that disability associated with depression may interfere with child-care activities, hence putting the child's health at increased risk. This is supported by substantial evidence that shows the negative effect of postnatal depression on the mother–infant interaction and psychological development.[9] Several studies from Western countries have also shown an association of maternal depression and child neglect with physical abuse.[10–12] However, links between preventable infectious illnesses such as diarrhoea and maternal psychological state around childbirth in low-income settings have not been extensively researched.

## What is already known on this topic

- Low-income countries have high rates of diarrhoeal illness in infants.
- Rates of postnatal depression in these countries are also high.

## What this study adds

- Infants of postnatally depressed mothers have more episodes of diarrhoea per year than infants of psychologically well mothers.
- This association is independent of the effects of known factors such as undernutrition, socioeconomic status and parental education.

The Global Burden of Disease Study, using mortality and years lived with disability, ranks diarrhoea and unipolar depression as the second and fourth most burdensome disorders, respectively.[13] The association between these two major public health problems indicates a need for integrated and holistic interventions that could be applied in a pragmatic way to reduce the immense burden on mothers and children in the developing countries.

## ACKNOWLEDGEMENTS

We are grateful to the Human Development Research Foundation, Islamabad for their assistance. We acknowledge the help of an anonymous referee in revising our sample size calculations using the software library asypow in the R statistical computing system (http://CRAN.R-project.org/).

## Authors' affiliations

**A Rahman,** Human Development Research Foundation, Islamabad, Pakistan
**J Bunn,** Department of Tropical Child Health, Liverpool School of Tropical Child health, Liverpool, UK
**H Lovel*,** WHO Collaborating Centre for Primary Care, University of Manchester, Manchester, UK
**F Creed,** School of Psychiatry and Behavioural Sciences, University of Manchester, Manchester, UK

*Current address: East of England Public Health Group, Department of Health, Cambridge CB2 2DF, UK.

Funding:This study was funded by a grant from the Wellcome Trust, UK (060177/Z/00/Z).

Competing interests: None.

This work is dedicated to the memory of Richard Harrington, Professor, Department of Child and Adolescent Psychiatry, University of Manchester, Manchester, UK, who supervised this work from 2000 until his untimely death in May 2004.

## REFERENCES

1 **World Health Organization**. The world health report. Geneva: WHO, 2000.
2 **Rahman A**, Iqbal Z, Harrington R. Life events, social support, depression and childbirth: perspectives from a rural population in a developing country. *Psychol Med* 2003;**33**:1161–7.
3 **Patel V**, Rodrigues M, DeSouza N. Gender, poverty, and postnatal depression: a study of mothers in Goa, India. *Am J Psychiatry* 2002;**159**:43–7.
4 **Rahman A**, Iqbal Z, Bunn J, *et al*. Impact of maternal depression on infant nutritional status and illness: a cohort study. *Arch Gen Psychiatry* 2004;**61**:946–52.
5 **World Health Organization**. *SCAN: schedule for clinical assessment in neuropsychiatry*. Geneva: WHO, 1994.

6 **Baqui AH**, Black RE, Yunus MD, *et al*. Methodological issues in diarrhoeal diseases epidemiology: definition of diarrhoeal episodes. *Int J Epidemiol* 1991:1057–62.
7 **Pakistan Medical Research Council**. *National Health Survey of Pakistan: 1990–94*. Islamabad: Pakistan Medical Research Council, 1998.
8 **StataCorp**. Stata Statistical Software: Release 7.0. College Station, TX: Stata Corporation, 2001.
9 **Grace SL**, Evindar A, Stewart DE. The effect of postpartum depression on child cognitive development and behavior: a review and critical analysis of the literature. *Arch Women Ment Health* 2003;**6**:263–74.
10 **Windham AM**, Rosenberg L, Fuddy L, *et al*. Risk of mother-reported child abuse in the first 3 years of life. *Child Abuse Negl* 2004;**28**:645–67.
11 **Walsh C**, MacMillan H, Jamieson E. The relationship between parental psychiatric disorder and child physical and sexual abuse: findings from the Ontario Health Supplement. *Child Abuse Negl* 2002;**26**:11–22.
12 **Cadzow SP**, Armstrong KL, Fraser JA. Stressed parents with infants: reassessing physical abuse risk factors. *Child Abuse Negl* 1999;**23**:845–53.
13 **Murray CJ**, Lopez AD. Global mortality, disability, and the contribution of risk factors: global Burden of Disease Study. *Lancet* 1997;**349**:1436–42.

# ARCHIVIST

## Convulsive status epilepticus

Every 2–3 h, on average, somewhere in England and Wales, a child begins an episode of convulsive status epilepticus (CSE). This is an extrapolation from data collected in north London during a 2-year period in 2002–4 (Richard Chinn and colleagues. *Lancet* 2006;**368**:222–9; see also Comment, ibid: 184–5), the first prospective, population-based study of CSE in children.

In a population of 605 230 children, 226 children aged 29 days to 15 years had at least one episode of CSE (lasting for at least 30 min) during the study period and 176 had a first episode. Of the children with first episodes, 95 (54%) were boys. After adjustment for case ascertainment (estimated at 62–84%), the incidence of CSE was 17–23 per 100 000 children per year. Extrapolation of the figures to England and Wales would suggest that between 1650 and 2240 children will have a first episode of CSE each year and that the total number of episodes will be between 3200 and 4300. The incidence decreased with age, from 51 per 100 000 per year in infants to 29 per 100 000 in children aged 1–4 years, 9 per 100 000 in children aged 5–9 years and 2 per 100 000 in children aged 10–15 years. In all, 92 (52%) first episodes were intermittent (repeated convulsions without recovery of consciousness), and 84 (48%) were continuous convulsions. Of the convulsions in the 176 first episodes of CSE, 151 were tonic–clonic, 23 tonic and 2 clonic. Also, 115 were thought to be primary generalised convulsions, 52 secondary generalised and 9 focal. The convulsions for 105 (60%) children lasted for >1 h. In all, 56 (32%) were prolonged febrile convulsions, 30 acute symptomatic convulsions, 29 remote symptomatic, 28 acute on remote, 18 idiopathic, 3 cryptogenic and 12 unclassified. The most common cause of acute symptomatic CSE was acute bacterial meningitis, followed by viral central nervous system infection, acute metabolic disturbance, head injury, drug-related convulsions, hypoxia and cerebrovascular disease. A total of 95 children had a febrile first CSE episode; 11 of these had acute bacterial meningitis, 56 prolonged febrile seizure, 21 a febrile illness superimposed on previous neurological abnormality and 7 a viral infection of the central nervous system. In all, 98 children were previously neurologically healthy; 56 of these had a prolonged febrile convulsion.

At least one recurrence of CSE with an average of 25 days between first episode and first recurrence was observed in 23 (13%) children with a first episode of CSE. Ten children had more than one recurrence. Children with a pre-existing neurological abnormality had three times the risk of recurrence within 1 year compared with neurologically healthy children. Seven children died; three with bacterial meningitis, three with progressive neurodegenerative disease of unknown cause and one with glutaric aciduria type 1. The death rate for first episodes of CSE was 3%.

CSE is fairly common in children. The most frequent cause is febrile convulsions, but a diagnosis of bacterial meningitis must be considered in children with febrile CSE. Recurrence of CSE is common, and the death rate for first episodes in this series was 3%.