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ARTICLE

School Performance and Social-Emotional Behavior of Primary School Children Before and After a Disaster

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ABSTRACT

OBJECTIVES. The purpose of this work was to evaluate the cognitive and social-emotional consequences in a general population of primary school children affected by the firework disaster in Enschede, the Netherlands, on May 13, 2000. The explosions caused tremendous damage in the surrounding neighborhood. Twenty-two people immediately died and >1000 were injured.

METHODS. This retrospective study assessed school performance and social-emotional behavior before and up to 3 years after the disaster. Objectively measured school test results in spelling and arithmetic/mathematics and multi-informant social-emotional behavioral assessments were compared between exposed and nonexposed primary school children. Multivariate logistic-regression was used to assess the relationship between exposure and cognitive and social emotional functioning.

RESULTS. On school performances, the children exposed to the disaster performed over a period of 3 years after the disaster as good as or better than classmates, controls, and a national reference population. Shortly after the disaster, exposed children even seemed to have better school test results than nonexposed children. Two to 3 years after the disaster, a significant effect of disaster exposure was found on social-emotional behavior. Problematic behavior was reported by teachers, parents, and the school doctor.

CONCLUSIONS. This study demonstrates a limited influence of disaster exposure on school performance in primary school children. This study also shows that teachers and youth health care practitioners especially should be aware of children starting school several years after a disaster. Although very young at the time of a disaster (1–4 years of age), they may experience disaster-related problems.

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Key Words
disaster, children, school performance, behavior, epidemiology

Abbreviations
PTSD—posttraumatic stress disorder
AS—affected area schools
CS—control school
SES—socioeconomic status
LSPPK—National Checklist for Indicating Psychosocial Problems in Five/Six Year Olds
SDQ—Strengths and Difficulties Questionnaire
OR—odds ratio
CI—confidence interval

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On MAY 13, 2000, a storage facility for heavy fireworks exploded in a residential area in Enschede, the Netherlands. This disastrous event resulted in the immediate death of 22 people, and >1000 others were injured. The explosions caused tremendous damage to homes in the surrounding neighborhood; >500 houses were destroyed, and >1000 houses were damaged. More than 800 primary school children were exposed to the disaster.

Several studies of children exposed to traumatic situations have reported a spectrum of posttraumatic symptoms including posttraumatic stress disorder (PTSD), anxiety, regressive behaviors, problematic social behaviors, sleep disturbance, attention problems, and school problems.[1–6] Yule,[3] for instance, reported that 11- to 18-year-old children who survived the sinking of a cruise ship developed specific fears related to trauma and showed significantly higher scores on anxiety and depression. Fourteen months after a hurricane, exposed preschool children showed significantly higher anxiety and withdrawal and more behavior problems than did children who had not experienced the hurricane.[7] Studies analyzing school performance generally report decreased cognitive functioning in exposed children. After the Buffalo Creek flood, for 5- to 11-year-olds, decreased school performance the semester after the disaster was most likely for the children with the most persisting postdisaster symptoms.[8] Shannon et al[5] studied self-reported school performance 3 months after Hurricane Hugo among 9- to 19-year-olds. Children positive for PTSD showed a significant decrease in school performance as compared with controls. A group of school-aged girls (adolescents) who survived a ship's sinking had had superior performance before the disaster but obtained only average grades a year later. The disaster survivors also had lower scores than control subjects on final examinations 2 years after the disaster.[9] Decreased school performance might have severe negative consequences for children. Long-term impairment may lead to considerable learning disabilities. It also may lead to social emotional problems, that is, loss of self-respect and negative self-esteem.[10] Moreover, behavioral and emotional problems are associated with the development of psychopathology.[11]

Information regarding school performance among disaster-exposed children is very limited. Most of the performed studies examined the relatively short-term consequences, used self-reported measures, or only analyzed postdisaster data. Moreover, few studies focused on primary school children. In 2003, the present study was, therefore, started to evaluate the cognitive and social-emotional consequences of the firework disaster among primary school children. It was conducted within the framework of the Enschede Firework Disaster Health Monitoring Project.[12] The main objective of this health surveillance project was to acquire information for health care providers and policy makers to match aftercare services to problems of the target group. Our study was designed to determine to what extent cognitive and social-emotional problems occurred among primary school children (aged 4–12 years) exposed to a disaster and how the occurrence changed over time. We systematically analyzed school performance and behavior for 4 school years among a general population of exposed and nonexposed primary school children.

METHODS

Participants

Six primary schools are located within or close to the affected area and were invited to participate in this research study. Five responded positively. The nonparticipating school, with a high proportion of children of non-Dutch origin (72%), expected to have to spend too much time answering questions from parents. One of the positively responding schools was excluded because of incomplete data, low response rate (28%), and a different educational system (Montessori). Therefore, data were collected from 4 schools located in the direct neighborhood of the affected area (affected area schools [AS]). A school in the same city in a different district with children unexposed by the disaster was included in the project for control data (control school [CS]). Except for behavioral data of 1 school year, all of the required data were available at the CS.

Primary education in the Netherlands lasts 8 years, for children aged 4 to 12 years. The primary schools are divided into 8 classes, each containing one age group. The study population consisted of children who attended the participating schools in the school year 2002–2003 (all 8 grades), lived in the town of Enschede at the time of the disaster, and whose parents gave written informed consent. More than half (54%) of the actual school population participated in the study. The total subject pool consisted of 720 children (aged 4–12 years). Of these children, 452 attended the schools near the affected area (193 exposed and 259 nonexposed) and 268 attended the CS. Demographic characteristics of the study population are presented in Table 1. The proportion of exposed children among the participants in the study was equal to that of the complete school population at the 4 participating schools near the affected area. At the time of the firework disaster (May 2000), the children in the study population were 1 to 9 years of age.

Data Collection

In June 2003, data from 4 school years (1999–2000 to 2002–2003) of the children attending the schools at that time were retrospectively collected. School year 1999–2000 provided data about school performance and behavior before and 2 to 4 weeks after the disaster, and the following years provided information on 6 months to 3

TABLE 1 **Demographic Characteristics of the Study Population in School Year 3 After the Disaster (2002–2003): Exposed and Nonexposed Children Attending the AS and CS**

Variable	AS		CS Controls, *N* (%)	Total (All Schools), *N* (%)	*P*, χ^2 Test	
	Exposed Children, *N* (%)	Nonexposed Children, *N* (%)			AS: Exposed vs Nonexposed Children	AS vs CS
Gender						
Male	96 (49.7)	132 (51.0)	138 (51.5)	366 (50.8)	NS	NS
Female	97 (50.3)	127 (49.0)	130 (48.5)	354 (49.2)		
Grade in 2002–2003 school year						
1	20 (10.4)	38 (14.7)	33 (12.3)	91 (12.6)	NS	.04
2	23 (11.9)	38 (14.7)	45 (16.8)	106 (14.7)		
3	29 (15.0)	40 (15.4)	39 (14.6)	108 (15.0)		
4	16 (8.3)	23 (8.9)	36 (13.4)	75 (10.4)		
5	24 (12.4)	37 (14.3)	36 (13.4)	97 (13.5)		
6	22 (11.4)	24 (9.3)	33 (12.3)	79 (11.0)		
7	24 (12.4)	27 (10.4)	27 (10.1)	78 (10.8)		
8	35 (18.1)	32 (12.4)	19 (7.1)	86 (11.9)		
SES						
Low	73 (37.8)	71 (27.4)	61 (22.8)	205 (28.5)	.04	.001
Moderate/high	120 (62.2)	188 (72.6)	207 (77.2)	515 (71.5)		
Life events other than firework disaster						
Yes	27 (14.0)	24 (9.3)	27 (10.1)	78 (10.8)	NS	NS
No	166 (86.0)	235 (90.7)	241 (89.9)	642 (89.2)		
Total	193 (100)	259 (100)	268 (100)	720 (100)		

NS indicates not significant.

years after the disaster. From pupils attending grades 4 to 8 in the school year 2002–2003, data of all 4 school years could be collected. For pupils attending grades 1 to 3 in the year 2002–2003, data could be collected from the moment they had started school. Therefore, in the school years preceding 2002–2003, analyses were performed with part of the sample. Of the total subject sample (attending grades 1–8 in school year 2002–2003), 55% attended school in 1999–2000 (children being in grades 1–5), 70% in 2000–2001 (grades 1–6), and 86% in 2001–2002 (grades 1–7).

Measures

Demographic Data

Information about the children's grade, ethnicity, nationality, gender, and socioeconomic status (SES) was obtained through school databases. The indicator for SES available was based on 2 variables: the child's country of birth and the parent's occupational or educational status. SES was scored "low" if children of Dutch origin had 2 parents with a lower educational status or if children of non-Dutch origin had ≥1 parent with a lower educational or occupational status and scored "moderate/high" for the other children.

Disaster Exposure and Other Life Events

Disaster-related information (ie, the child's location during the explosions and the locations of the child's home) was collected from school files. In some cases an additional questionnaire was filled out to provide these data. Children were included in the exposed group if they met ≥1 of the following criteria: (1) child's home was located in affected area (geographically defined area by city council); (2) child's home was destroyed or damaged; (3) child was present in affected area during explosions; (4) child was injured; and (5) ≥1 family member, friend, or schoolmate died or was injured. Information about life events other than the firework disaster also was collected from school files, that is, hospitalization, death of a family member, divorce, (possible) sexual abuse, and so forth. An event was considered present from the moment it occurred in the school file.

Cognitive School Performance

Information about school performance and behavior was collected from the children's school files. By using data usually registered at school, predisaster data about school performance and behavior also could be analyzed. All of the participating schools used the same standard tests to measure school performances throughout primary education. These are reliable and validated tests provided by the Central Institute for Educational Measurement, known as Cito-tests. The periodic nature of the assessments (half-yearly: summer and winter tests) made it possible to compare the situation at different points in time. Children's test results in the following 2 main educational domains were selected: Dutch language (spelling) and arithmetic/mathematics (numbers and operations involving addition, subtraction, multiplication, division, fractions, percentages, and proportions).

Based on the number of questions answered correctly, the Central Institute for Educational Measurement constructs test scores. These test scores are transformed into 5 levels (A to E) based on a national representative sample. Levels A to C are assigned to the highest 75% of the scores, whereas levels D and E are assigned to the lower 25% of the scores.[13]

These tests were made by pupils in grades 3 to 8 (6- to 12-year-olds). Results of specific tests for children in the first 2 years of primary education (aged 4–6 years) were also collected. However, the study population of these young children was too small to analyze the data properly.

Social-Emotional Behavior

Information on social-emotional behavior was based on annual teacher's reports and data from the regional health authority (school doctor). Teachers regularly (yearly) keep a record of the performance of each child concerning playing behavior (quality and playing together), work behavior (attitude to work and working according to plan), and social behavior (social initiative, aggression, self-esteem, assertiveness, and rule-breaking behavior). They indicate behavior on a general behavior problem checklist on a 3-point scale. Behavior was scored "problematic" if the score was 1 or 2 and scored "desirable" for children with a score of 3. For instance, for the item "playing together," the corresponding scores were as follows: (1) "the child is mainly playing alone," (2) "the child is occasionally playing together with others," or (3) "the child is sufficiently playing together with others." Records were kept for pupils in grades 1 to 8 (4- to 12-year-olds). Those teacher's reports are structured questionnaires but have not been properly tested for reliability and validity.

To obtain data from multiple informants, data about behavior collected by the youth health care department of the regional health authority of Enschede were also analyzed. In the Netherlands, school doctors examine children several times during their school careers. Our population visited the school doctor in grades 2, 4, and 7. To identify psychosocial problems, question forms were filled out by parents and/or the school doctor. For pupils in grade 2, the LSPPK (Dutch acronym for National Checklist for Indicating Psychosocial Problems in Five/Six Year Olds) was used[14]; for children attending grade 4 and 7, the Dutch version of the Strengths and Difficulties Questionnaire (SDQ) for parents was used.[15] The LSPPK is a 9-item questionnaire developed for the purpose of examining 5- to 6-year-olds. Parents are asked to fill out the checklist at home and discuss it during their visit to the school doctor (parent index). After the meeting, the school doctor adds his/her opinion to every item (child health professional index). The items cover 3 domains: behavioral, cognitive development, and emotional problems. Problems are considered present if the category "worried a bit" or "very worried" is indicated and absent with the category "not worried." Data from a national reference population are available.[16] For a score of 3 to 4 items of concern mentioned by the parents, school doctors seriously consider referring children to mental health service for making a proper diagnosis and possibly further preventive actions.[14] Any problem indicated on the child health professional index is also considered to indicate a serious problem that needs referral to a mental health professional.[17] The SDQ is a short behavioral screening questionnaire consisting of 25 items. The SDQ version that was used was filled out by the parents. They rated the presence of certain behaviors on a 3-point scale (0 = not true, 1 = somewhat true, and 2 = certainly true). The time period was the last 6 months. The 25 items were divided between the following 5 scales: emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behavior. The first 4 scales were also added together to generate a total difficulties score. Cases were allocated to a reference range, a borderline range, or a clinical range of the scoring distributions based on the British normative sample, because the Dutch normative sample was considered biased.[18] Cutoffs were set at the 90th percentile for the clinical problems and at the 80th percentile for the borderline problems. LSPPK and SDQ data were only available 2 and 3 years after the disaster (school years 2001–2002 and 2002–2003). Because pupils visit the school doctor only in grades 2, 4, and 7, analyses were performed on part of the original subject sample. A total of 111 grade 2 pupils visited the school doctor in 2001–2002 and 2002–2003 (21 exposed, 50 nonexposed at AS, and 40 controls). SDQ data were available in those years from 247 grade 4 and 7 pupils (56 exposed, 73 nonexposed at AS, and 118 controls).

Data Analysis

A cross-sectional approach was used to evaluate school performance and social-emotional behavior before and at different points in time after the disaster. The percentage of children with low school performance levels/problematic behavior was compared between exposed and nonexposed children of the schools close to the affected area and between all of the children at the AS and the children at the CS. Because of small numbers, grades were pooled in the analyses. Therefore, in these analyses, the composition of the group for exposed and nonexposed children slightly differed for each year, because children in the lower grades were not yet attending school in earlier years (see data collection paragraph).

We also analyzed changes over time in school performance and behavior for the subgroup of children who were already attending school when the disaster occurred (grades 4 or higher; referred to as "longitudinal analyses"). In those analyses, every year the same group

of children contributes to the group of the exposed, nonexposed, and control subjects. The proportion of children with decreasing school performance or behavior after the disaster compared with before the disaster was compared between exposed and nonexposed children of the schools close to the affected area and of all of the children at the AS with the children at the CS. The relationship between exposure and cognitive and social emotional functioning was assessed by means of multivariate logistic regression. In the cross-sectional analyses, the outcome was dichotomized as low score versus average/good score for school performance, as problematic versus desirable behavior for social-emotional functioning, and in the longitudinal analyses as a decrease in school test levels/behavior score versus stable or improved school test levels/behavior score. All of the independent child variables were dichotomized. Odds ratios (ORs) and 95% confidence interval (CIs) adjusted for SES, school/grade, and other life events are presented in the analyses of differences between groups in school performance and behavior. Significance was at an α level of .05. All of the statistical analyses were performed using SPSS 11.05 for Windows (SPSS Inc, Chicago, IL).

RESULTS

Table 1 presents the frequencies, percentages, and results from the χ^2 tests of independence for demographic characteristics in the third school year after the disaster. The percentage of exposed children was not the same for all 4 of the schools close to the affected area; for 1 school in particular it differed (data not shown). Exposed children had a lower SES than the nonexposed children. In the first year after the disaster, exposed children had experienced more life events other than the firework disaster than nonexposed children (data not shown). Children attending the AS had lower SES and were in different grades as compared with those attending the CS. In the logistic regression analyses, we adjusted for these variables. No significant differences were found for gender.

School Performance

Table 2 shows cognitive school test results before and after the disaster. At the AS, shortly (2–4 weeks) after the disaster a significant relationship between disaster exposure and cognitive functioning (spelling test) was found. The proportion of nonexposed children with low levels (32.5%) was higher than that of exposed classmates (22.5%). At that moment, the children in the sample attended grades 3 to 5 (aged 6–8 years). Overall, the study sample subjects performed similar to or better than the national reference sample subjects (25% low levels), except the nonexposed children shortly after the disaster, as mentioned before. In analyses by gender, shortly after the disaster an effect of disaster exposure was seen among both girls and boys. At the AS, 2 to 4 weeks after the disaster, exposed girls seemed to have performed better in the language test than nonexposed girls (5% vs 24% low levels). Exposed boys performed better the semester after the disaster in the arithmetic/

TABLE 2 **Low Test Levels in Dutch Language (Spelling) and Arithmetic/Mathematics per Assessment Moment**

Variable	AS			CS		AS: Exposed vs Nonexposed, OR (95% CI)[a]	AS vs CS, OR (95% CI)[b]
	N	Exposed, *N* (%)	Nonexposed, *N* (%)	*N*	Controls, *N* (%)		
Dutch language (spelling)							
1999–2000 (winter)	101	14 (29.2)	12 (22.6)	65	13 (20.0)	0.87 (0.29–2.57)	1.29 (0.57–2.95)
1999–2000 (summer)	80[c]	9 (22.5)	13 (32.5)	65	7 (10.8)	0.23 (0.06–0.94)[d]	3.32 (1.25–8.82)[d]
2000–2001 (winter)	138	17 (26.2)	15 (20.5)	106	23 (21.7)	1.20 (0.49–2.93)	0.98 (0.50–1.90)
2000–2001 (summer)	172	19 (22.9)	18 (20.2)	106	25 (23.6)	0.85 (0.34–2.10)	0.78 (0.42–1.44)
2001–2002 (winter)	232	32 (29.1)	33 (27.0)	137	32 (23.4)	1.05 (0.53–2.06)	1.18 (0.71–1.96)
2001–2002 (summer)	199	22 (25.3)	18 (16.1)	139	29 (20.9)	2.76 (1.15–6.60)[d]	0.97 (0.56–1.70)
2002–2003 (winter)	275	29 (23.2)	31 (20.7)	166	37 (22.3)	1.25 (0.67–2.32)	0.76 (0.46–1.25)
2002–2003 (summer)	220	12 (12.6)	16 (12.8)	161	39 (24.2)	1.08 (0.47–2.49)	0.44 (0.25–0.76)[d]
Arithmetic/mathematics							
1999–2000 (winter)	52	5 (20.0)	4 (14.8)	18	3 (16.7)	0.68 (0.10–4.66)	1.06 (0.23–4.79)
1999–2000 (summer)	42[c]	3 (15.0)	4 (18.2)	18	2 (11.1)	0.88 (0.15–5.06)	1.73 (0.32–9.48)
2000–2001 (winter)	108	13 (24.5)	14 (25.5)	38	5 (13.2)	0.85 (0.34–2.12)	2.04 (0.71–5.86)
2000–2001 (summer)	95	10 (23.3)	11 (21.2)	38	6 (15.8)	1.16 (0.42–3.20)	1.43 (0.52–3.93)
2001–2002 (winter)	123	15 (25.9)	17 (26.2)	41	7 (17.1)	0.94 (0.39–2.25)	1.52 (0.60–3.88)
2001–2002 (summer)	103	11 (22.0)	14 (26.4)	40	9 (22.5)	0.70 (0.26–1.88)	1.00 (0.40–2.47)
2002–2003 (winter)	146	17 (25.8)	17 (21.3)	77	12 (15.6)	1.65 (0.69–3.95)	1.51 (0.71–3.24)
2002–2003 (summer)	82	7 (17.9)	10 (23.3)	56	7 (12.5)	0.68 (0.20–2.32)	2.02 (0.74–5.52)

The 1999–2000 winter was predisaster. Comparisons of exposed and nonexposed children at AS and between children at AS and CS (cross-sectional analyses).

[a] Adjusted for SES and school.

[b] Adjusted for SES and grade.

[c] Smaller number of children because of assessment of summer school tests at one school before the disaster took place.

[d] $P \leq .05$.

mathematics test than nonexposed boys (8% vs 22% low levels). However, both of these differences were not significant ($P = .17$ and $P = .06$, respectively).

Comparing all of the children at the AS with children at the CS, a significant difference was found for the language test results shortly (2–4 weeks) after the disaster. The children at the CS performed significantly better than the children at the AS. However, at the CS, the proportion of low test levels was relatively low compared with the national sample. Analysis by gender showed that boys at the AS (38% low levels) performed significantly worse than controls (12% low levels) with an adjusted OR (adjusted for SES and grade) of 4.41 (95% CI: 1.19–16.30). This result is accounted for by a difference between the nonexposed boys and controls (adjusted OR: 5.20; 95% CI: 1.11–24.3) and not between the exposed boys and controls. No significant differences between AS and CS among girls were found. Three years after the disaster, an opposite effect was found. More children at the CS had low language test levels than at the AS. At the AS, as well as the CS, test results were comparable to or better than those of the national reference population.

In addition, a longitudinal analysis of performance was conducted for a constant group of children from higher grades. Only those children who already attended school when the disaster took place were included. At the schools close to the affected area, no significant difference between the exposed and the nonexposed subjects was found on school performance (results not shown). Comparison of the total AS sample with the CS showed a significantly stronger decrease in test levels for both language and arithmetic/mathematics (1 and 2 years after the disaster, respectively) among CS children versus AS children.

Social-Emotional Behavior

Annual Teacher's Reports

At the schools close to the affected area, the variable on which the exposed and nonexposed children differed significantly was the teacher's report of problematic social behavior 2.5 years after the disaster, indicating 37.8% of exposed children as showing problematic social behavior versus 22.2% of nonexposed children (Table 3). Separate analyses for boys and girls revealed an effect of disaster exposure among boys (OR: 2.62; 95% CI: 1.13–6.09).

Between the children at the AS and CS, a significant difference was found 1.5 years after the disaster (winter 2001–2002) for playing, working, and social behavior (Table 3). For all of the variables, a significant difference between the girls at the schools close to the affected area and controls was found with adjusted ORs (adjusted for gender, life events, and grade) of 8.01 (95% CI: 2.80–22.91) for playing, 2.67 (95% CI: 1.03–6.90) for working, and 3.88 (95% CI: 1.78–8.44) for social behavior. No significant differences between boys at the AS and CS were found. A longitudinal analysis of behavior for a constant group of children attending grades 4 to 8 in 2002–2003 (and grades 1–4 in 1999–2000) revealed no significant changes in behavior.

Parent's and School Doctor's Reports

In school years 2 and 3 after the disaster, no differences were found between exposed and nonexposed grade 2

TABLE 3 **Problematic Behavior as Indicated by the Teacher per School Year**

Variable	AS			CS		AS: Exposed vs Nonexposed, OR (95% CI)[a]	AS vs CS, OR (95% CI)[b]
	N	Exposed, *N* (%)	Nonexposed, *N* (%)	*N*	Controls, *N* (%)		
Playing behavior							
1999–2000 (winter)	103	11 (26.2)	16 (26.2)	134	30 (22.4)	0.44 (0.13–1.49)	1.36 (0.68–2.73)
2000–2001 (winter)	147	13 (19.7)	10 (12.3)	144	28 (19.4)	0.81 (0.25–2.63)	0.56 (0.29–1.18)
2001–2002 (winter)	269	29 (26.1)	30 (19.0)	209	21 (10.0)	1.24 (0.67–2.30)	2.43 (1.38–4.26)[c]
2002–2003 (winter)	297	25 (18.5)	18 (11.1)			1.50 (0.76–2.95)	
Working behavior							
1999–2000 (winter)	102	13 (31.0)	15 (25.0)	134	31 (23.1)	1.72 (0.62–4.76)	1.36 (0.71–2.60)
2000–2001 (winter)	132	17 (32.1)	22 (27.8)	144	32 (22.2)	1.14 (0.48–2.70)	1.39 (0.77–2.52)
2001–2002 (winter)	267	45 (40.5)	40 (25.6)	209	40 (19.1)	1.56 (0.87–2.77)	1.70 (1.08–2.67)[c]
2002–2003 (winter)	297	58 (43.0)	63 (38.9)			0.97 (0.59–1.58)	
Social behavior							
1999–2000 (winter)	103	13 (31.0)	19 (31.1)	134	38 (28.4)	0.57 (0.18–1.82)	0.95 (0.50–1.81)
2000–2001 (winter)	146	23 (35.4)	23 (28.4)	144	35 (24.3)	0.83 (0.35–2.00)	1.32 (0.75–2.32)
2001–2002 (winter)	271	46 (41.4)	45 (28.1)	209	39 (18.7)	1.53 (0.89–2.64)	1.77 (1.13–2.78)[c]
2002–2003 (winter)	297	51 (37.8)	36 (22.2)			1.75 (1.02–3.00)[c]	

The 1999–2000 winter was predisaster. Comparisons of exposed and nonexposed children at AS and between children at AS and CS (cross-sectional analyses).

[a] Adjusted for SES, life events, and school.

[b] Adjusted for SES, life events, and grade.

[c] $P \leq .05$.

children at the schools close to the affected area with respect to concerns by parents or the school doctor (LSPPK data). Only parents of exposed children reported significantly more worries and fears for their children (adjusted OR: 3.92; 95% CI: 1.01–15.3). Also compared with normative data, parents of exposed children mentioned these concerns far more often (35.0% vs 2.5% in a national reference population). However, no significant effect of disaster exposure was found for the school doctor's perception of these children's worries/fears. According to the school doctor's opinion, these worries/fears were related to other life events than the firework disaster.

When all of the grade 2 children at the AS are compared with the CS, school doctors mention significantly more often concerns for children at the schools close to the affected area (adjusted OR: 4.35; 95% CI: 1.11–17.1). The school doctor reported ≥1 concern in 34.8% of exposed children and 11.4% of the control subjects (Table 4, LSPPK). Normative data show a prevalence of 21.1%.[16] Any concern mentioned by the school doctor is considered to indicate a serious problem. The school doctor especially indicated significantly more often "demanding attention in an annoying way" for children at the schools close to the affected area (OR: 9.55; 95% CI: 1.04–87.7). Further analysis revealed that there was a significant difference between the exposed children at the AS and CS (and not between those nonexposed at the AS and CS).

On the SDQ scales among grades 4 and 7 children, no significant effect of disaster exposure was found at the schools close to the affected area in the second or third school year after the disaster. The total group of children at the schools near the affected area differed, however, significantly from the children at the CS for borderline total difficulties score (Table 4, SDQ). The one SDQ subscale on which the total AS sample and the controls differed significantly was the borderline SDQ subscale peer problems (adjusted OR: 4.88; 95% CI: 1.67–14.3). This could be attributed to differences between the girls and not the boys. Parents of girls at the AS more often indicated possible problems with peers than parents of control girls (adjusted OR: 15.9; 95% CI: 1.77–143.3).

DISCUSSION

The results reported here show that, contrary to previous reports about cognitive impairment,[5,8,9] the school performances of a general population of children exposed to a firework disaster were hardly influenced. Over a period of 3 years after the disaster, exposed primary school children performed on 6-month objectively measured language and arithmetic/mathematic school tests as good as or better than classmates, control subjects, and a national reference population. School performance did not deteriorate for the exposed children in our study population. On the contrary, shortly after the disaster, school performances of exposed girls, as well as exposed boys (aged 6–9 years at the time of the disaster), seem to have temporarily improved in the domain that they usually have better results in versus the opposite gender (girls in spelling and boys in arithmetic/mathematics). Similar findings have not been reported in the literature for cognitive performance, but studies concerning social-emotional behavior found that exposure to trauma may lead to constricted or improved behavior in some, at least initially.[1,6] After the disaster, at the schools in the direct neighborhood of the affected area, exposed children participated in various school-based intervention programs (including small group activities and projective techniques, such as play, artwork, storytelling, and role playing). In addition, more time was spent by special care teachers on individual remedial teaching. This may have had an effect in the prevention of cognitive impairment. However, no proper evaluation of those intervention programs has taken place.

For social-emotional behavior, the results suggest that 2 to 3 years after the disaster, parents, teachers, and school doctors had more concerns about exposed chil-

TABLE 4 **Concerns Mentioned by Parents and School Doctors for Grade 2 Children (LSPPK) and by Parents of Grade 4 and 7 Children (SDQ) in Years 2 and 3 After the Disaster**

Variable	AS			CS		AS: Exposed vs Nonexposed, OR (95% CI)[a]	AS vs CS, OR (95% CI)[b]
	N	Exposed, *N* (%)	Nonexposed, *N* (%)	*N*	Controls, *N* (%)		
LSPPK							
≥4 concerns mentioned by parents	66	2 (10.0)	5 (10.9)	40	6 (15.0)	1.08 (0.18–6.55)	0.48 (0.11–2.04)
≥1 concern mentioned by school doctor	68	8 (34.8)	9 (20.0)	35	4 (11.4)	2.55 (0.76–8.57)	4.35 (1.11–17.1)[c]
SDQ parents							
Borderline total difficulties score	56	5 (8.9)	6 (8.2)	73	2 (1.7)	0.62 (0.16–2.49)	6.29 (1.32–29.9)[c]
Clinical total difficulties score	56	7 (12.5)	3 (4.1)	73	6 (5.1)	4.71 (0.86–25.8)	1.88 (0.63–5.62)

Comparisons of exposed and nonexposed children at AS and between children at AS and CS (cross-sectional analyses).

[a] Adjusted for SES, life events, and school.

[b] Adjusted for SES, life events, and grade.

[c] $P \leq .05$.

dren than the nonexposed children. At the time that the disaster occurred, these children were 1 to 9 years of age. The effect of the disaster on children's behavior found by us is generally comparable with earlier studies. Exposed boys seemed to show mainly externalizing symptoms. Teachers reported problematic social behavior of exposed boys, for example, aggressiveness and assertiveness. This finding is similar to earlier studies.[19] Previous studies generally report more postdisaster symptoms in school-aged girls than school-aged boys.[20,21] In this study, teachers as well as parents indicated more problems for girls at the school near the disaster area. Teachers had concerns about a wide range of behavior problems in these girls (playing and working, as well as social behavior), especially playing behavior. This impaired playing behavior might be in accordance with the parents' opinion indicating disturbances in peer relationships. Very remarkable is the finding that 2 to 3 years after the disaster, the school doctor had concerns about more than one third (34.8%) of the 5- to 6-year-old exposed children. These children, just 1 to 4 years at the time of the disaster, probably developed specific behavior caused by impaired parental functioning.[21] The finding of more social-emotional behavior problems 2 to 3 years after the disaster at the schools near the affected area confirms the long-term impact of disaster. It also may suggest that, in the long run, the school-based interventions were not entirely effective in preventing social-emotional problems. However, they might have prevented more serious postdisaster symptoms, because no significant effects on clinical SDQ scales were found. For behavior, more significant differences were found when comparing all of the children at the schools close to the affected area with control subjects than within AS (exposed versus nonexposed). Possibly, the nonexposed children at the AS were influenced by experiences of their exposed classmates. Other than small group activities especially held for exposed children, there also were interventions for the complete school population. In general, at the schools in the direct neighborhood of the affected area, there was a considerable amount of attention paid for the firework disaster and its effects. This may have resulted in smaller differences for social-emotional behavior between the exposed and the nonexposed children at these schools. However, in comparison with a control group at a school with very limited disaster involvement, impaired behavior was more prevalent among the AS population as a whole. It should be noted that differences between exposed and nonexposed children/control subjects may have been caused by changes in the group of nonexposed children/control subjects. Significant effects were not always caused by a changing performance among children in the exposed group.

This study was hampered by some methodologic limitations. Starting from a population of children attending the schools in 2002–2003, at the time that the disaster occurred (May 2000) only part of this population already attended school. Furthermore, youth health care practitioners examined the school children in a limited number of grades. It is possible that not finding significant group differences may be attributed to the relatively small sample size. On the other hand, we might have found group differences to be statistically significant where such significance was the result of chance alone, because we conducted so many tests. However, the significant differences found (10) clearly outnumber the differences expected on the base of chance alone (3, at an α level of .05). In this retrospective study, information about exposure status was set by the availability of data. We were able to collect individual exposure data by using disaster-related information from the school files. In the week after the disaster, only 1 of the schools had distributed a questionnaire to systematically record the children's experiences during the firework storage explosions and to record the disaster-related family consequences. The other schools had written down notes about exposure status in the general school files based on their knowledge of the children's living situation and what the parents told them. The data are considered to be complete and of good quality. Of each child, all of the known particularities were thoroughly written down in their school files, including disaster-related details. We believe that misclassification in our study is highly unlikely. The events covered in the exposure status definition are serious and of high relevance for all of the caregivers of young children and could without any exceptions be found in the school files. Moreover, for the schools, it was of importance to set down all of the disaster related aspects, because they had to report these (on a group level) to the local government. We used data that were mostly collected a short time after the disaster, except for children who did not visit school at that time. Therefore, we assume little risk of recall bias. The measures to study school performance and behavior also were set by the availability of instruments at the schools. For school performance, validated objective measures could be used, and data from a national reference population were at our disposal. Results of exposed children could be set into perspective to data of a control population in the same city, as well as to Dutch national norm data. For social-emotional functioning, however, only subjective instruments were available. Moreover, for the instruments used by the teachers, no normative data were available. By using data from the school doctor's health examinations of the same children, we could provide multi-informant data and put social-emotional behavior into perspective to normative data. This additional information from the school doctors and/or the parents supported the teacher's view of the children. Concerning the school-based data for social-emotional behavior, some information bias might have been possible. Teachers could be influenced by their knowledge

of the children's exposure. However, bias in this outcome measure could have affected the results in 2 opposite ways. Teachers might have overestimated the disturbance in social-emotional behavior because they knew the child was exposed to the disaster. On the other hand, they also might have reduced the behavior disturbance. Taking into consideration that the child had been exposed to the disaster, his or her behavior could be considered as good. School control data came from a CS located in the city in which the disaster took place. This school was located in a different district. However, it is possible that children at the CS in a small way were exposed. They may have heard the explosions, and it is very likely they saw or read about the disaster in the media. However, both of these exposure aspects were not included in our criteria for exposure status. Inclusion in the exposed group of children who, for instance, saw the explosions or were exposed to the media coverage of the disaster might have affected our findings but would have led to an underestimation of effects. Moreover, media exposure certainly was not limited to children within the city of Enschede. The disaster media coverage was nationwide, comprehensive, and continued for days, weeks, and even years. Therefore, not only children from the city of Enschede could be influenced by the disaster. Two years after the Oklahoma City, OK, bombing, among 11-year-olds who lived 160 km distant from the disaster, who had neither any direct physical exposure nor personally knew anyone killed or injured in the explosion, media exposure was a significant predictor of PTSD symptomatology.[22] In a country as small as the Netherlands, this range of 160 km from Enschede concerns a major part of the country.

Further research is needed to examine the impact of a disaster on young children, especially concerning their social-emotional functioning. However, this study is a valuable addition to the limited number of studies performed to analyze the effect of disaster on cognitive functioning. The objective measurement of school performance in primary school children before as well as after the disaster especially adds to the importance. Furthermore, the use of data of a control group and of a national reference population is valuable to be able to put performances at schools highly affected by a disaster into perspective. This study demonstrates a limited influence of disaster exposure on school performance in primary school children. Little is known about the role of school-based postdisaster intervention programs, and this should be investigated in the future. Further longitudinal studies are needed to address risk factors and factors protecting disaster-exposed children from developing behavior disturbances. This is essential to develop evidence-based preventive measures to be used in postdisaster intervention programs and in the training that needs to be given to teachers and pediatricians to help children cope. Other than confirming the potentially long-term social-emotional effects of disasters, this study also showed that teachers and youth health care practitioners should especially be aware of children starting school several years after a disaster. Although very young at the time of a disaster, they may experience disaster-related problems.

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School Performance and Social-Emotional Behavior of Primary School Children Before and After a Disaster

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