

The effect of a severe disaster on the mental health of adolescents: a controlled study

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Summary

Background Disasters greatly affect the mental health of children and adolescents, but quantification of such effects is difficult. Using prospective predisaster and postdisaster data for affected and control populations, we aimed to assess the effects of a severe disaster on the mental health and substance use of adolescents.

Methods In January, 2001, a fire in a café in Volendam, Netherlands, wounded 250 adolescents and killed 14. In the 15 months before the disaster, all grade 2 students (aged 12–15 years) from a school in Volendam (of whom 31 were in the café during the fire), and from two other schools, had been selected as controls for a study. 124 Volendam students and 830 from the other two schools had provided data for substance use, and completed the youth self-report (YSR) questionnaire about behavioural and emotional problems. 5 months after the disaster, we obtained follow-up data from 91 (response rate 73·4%) Volendam adolescents and 643 (77·5%) controls from the other two schools. The primary outcome measures were changes in score in YSR categories of total problems, alcohol misuse, smoking, and substance use. We compared changes in scores between groups using logistic regression.

Findings Volendam adolescents had larger increases in clinical scores than controls for total problems (odds ratio 1·82, 95% CI 1·01–3·29, $p=0·045$) and excessive use of alcohol (4·57, 2·73–7·64, $p<0·0001$), but not for smoking or use of marijuana, MDMA (ecstasy), and sedatives. Increases in YSR scores were largest for being anxious or depressed (2·85, 1·23–6·61), incoherent thinking (2·16, 1·09–4·30), and aggressive behaviour (3·30, 1·30–8·36). Intention-to-treat analyses showed significantly larger for increases in rates of excessive drinking and YSR symptom subscales in Volendam adolescents than controls. Effects were mostly similar in victims and their classmates.

Interpretation Mental health interventions after disasters should address anxiety, depression, thought problems, aggression, and alcohol abuse of directly affected adolescents and their peer group.

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Introduction

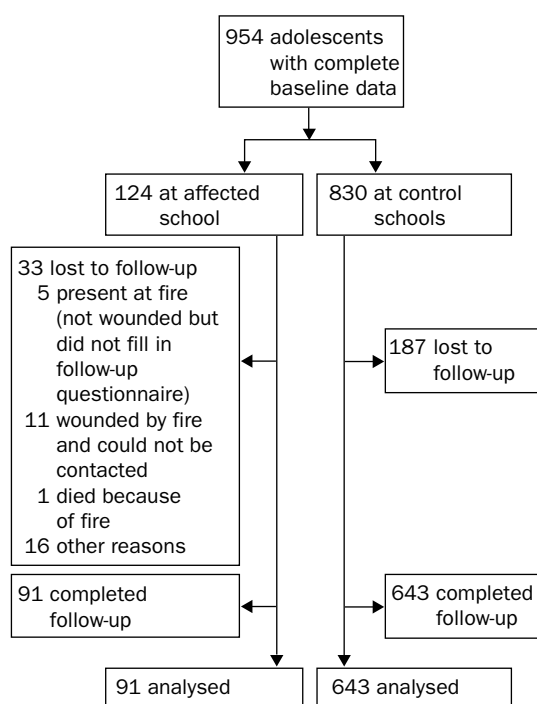
Disasters have substantial effects on the mental health of children and adolescents including symptoms of depression and anxiety, substance abuse, and difficulties with concentration, memory, behaviour, school, and sleep.^{1–5} Many of these effects seem to be on a continuum of stress responses, including post-traumatic stress disorder.^{2,3,5,6}

Evidence shows that mental health outcomes of disasters are determined by the characteristics of the disaster, the individual, and the environment. Effects are increased if a child perceives a strong life threat, is injured, or has relatives or close friends who are injured.^{2–5} Older children tend to be more severely affected than younger children, especially with respect to self-reported emotional symptoms in girls,^{2–5} and pre-existing psychopathological disorders.^{2,3} Finally, a severe parental reaction, and long-term family and environmental disruption worsen mental health outcomes.^{2–4}

Because of the unexpected nature of disasters, most investigations include people who were exposed to the event, and sometimes also people not exposed who were selected after the disaster.^{1,3,7} Such studies might have bias in their selection of exposed and unexposed groups, and use of retrospective information about health before the disaster.^{3,8} These biases generally lead to an overestimation of effects.⁷ Prospective investigations that have data for mental health before disasters are rare. Although Bromet and Dew³ identified four studies with such data, none of these had controls who were assessed at the same time as the affected group.^{8–11}

On Jan 1, 2001, at 0030 h, a fire started in a popular youth café on the dyke of Volendam, a town in the west of the Netherlands. The fire killed four adolescents immediately and wounded about 250.^{12,13} Of the 203 victims who were admitted, mainly for burns, 40 had to stay for over a month. 21 were admitted outside the Netherlands because the capacity of the Dutch burn units was exceeded.^{12,13} A total of 14 adolescents died.¹³ Almost all 300 adolescents who were in the fire lived in Volendam. The disaster had a great effect on the local community and the rest of the Netherlands.

At the time of the disaster, students of a school in Volendam and of two other schools in the Netherlands were controls in a study on the effects of a school health-promotion programme. The programme consisted of school-based interventions to prevent behavioural and emotional problems, smoking initiation, excessive use of alcohol, and use of psychoactive substances. The programme was planned to run from November, 1999, to April, 2001. Baseline measurements for the programme outcomes had been taken 15 months before the disaster. In the Volendam school (940 students in total), about 200 students were present at the café fire; of these, 140 were wounded. Thus, this investigation resembles an actual experiment in which adolescents would be assigned to groups—ie, a natural experiment.^{14,15} We therefore



Participant flow and follow-up

analysed our observational data in accord with CONSORT criteria for the analysis of randomised controlled trials,¹⁶ to best obtain information from this study.

Methods

Participants

In the affected school, 124 students aged 12–15 years (mean 13·6) had completed the baseline questionnaire. Of these, 31 were at the fire, 17 of whom were wounded. The other two schools were unaffected by disasters and both were located in the middle of the Netherlands, about 80 km from the affected school. 830 students aged 12–15 years (mean 13·8) had completed the baseline questionnaire. These students are controls in this study. At baseline, all adolescents were informed about the nature of the original study, and that a second measurement would be taken.

The original study protocol had been approved by the medical ethics committee of TNO Prevention and Health, Leiden, and included consent from the parents' council of every school. We informed the committee about the fire.

After discussing the situation with the headmaster of the affected school, we continued the study with the inclusion of additional questions about satisfaction with school-based care after the disaster and whether students' needs had been met. Results were reported to the school management immediately after follow-up, to assist in further post-disaster school planning.

Procedures

In September–October, 1999, students had completed a baseline questionnaire consisting of the youth self-report questionnaire (YSR),^{17,18} questions about smoking,¹⁹ and use of alcohol, marijuana, sedatives and hypnotics, and MDMA (ecstasy). YSR scores, smoking, and use of alcohol were the primary endpoints of the original study, and remained so in the postdisaster analyses. The YSR was used to assess the adolescent's report of their behavioural and emotional problems in the preceding 6 months. Its reliability and validity have been replicated for the Dutch translation from English.^{17,18} We also obtained data for sex, age, level of education (lower or higher—ie, junior secondary vocational education or general secondary education US higher), ethnic background (of child and both parents—at least two born in the Netherlands, or other), religion (Christian, other, or none), and parental employment (one or both parents working more than 3 days per week, or other).

As planned, all students completed the same questionnaire in May, 2001. To ensure comparability of information, we took no measures to increase the response of Volendam adolescents. We added some questions to the end of the Volendam students' questionnaires regarding their exposure to the fire, and school-based postdisaster care. Data for fire exposure of those lost to follow-up were provided by the school management. Responses were anonymous and could only be linked by school code, sex, date of birth, and initials of the adolescent.

For the analyses, we dichotomised all outcome measures, using cut-offs as planned in the original study. Of the YSR, we used only the items relating to mental health problems and calculated scores for nine symptom subscales, two broad groups of symptoms designated internalising and externalising (each comprising several symptom subscales of emotional and behavioural problems, respectively), and a total problems score. Adolescents were allocated to a normal or clinical range, with the 98th percentile of the Dutch normative sample as cut-off for symptom subscales, and the 90th percentile for other scales.¹⁸ Smoking was defined as at least one cigarette

	Analysed group			Lost to follow-up			p†
	Affected (n=91)	Control (n=643)	p*	Affected (n=33)	Control (n=187)	p*	
Girls	57 (62·6%)	314 (48·8%)	0·014	21 (63·6%)	88 (47·1%)	0·08	0·80
Mean (95% CI) age	13·59 (13·52–13·67)	13·75 (13·71–13·79)	0·004	13·75 (13·60–13·91)	13·86 (13·78–13·94)	0·29	0·004
Aged 14 years and older	11 (12·1%)	169 (26·3%)	0·003	9 (27·3%)	65 (34·8%)	0·40	0·007
In low-level education	34 (37·4%)	343 (53·5%)	0·004	13 (39·4%)	103 (55·4%)	0·09	0·70
Non-Dutch ethnic background	0 (0·0%)	58 (9·1%)	0·003	3 (9·7%)	19 (10·4%)	1·00	0·29
Christian religion	63 (70·8%)	162 (26·0%)	<0·0001	20 (62·5%)	46 (25·7%)	<0·0001	0·76
Other religion	2 (2·2%)	85 (13·6%)		3 (9·4%)	19 (10·6%)		
No parent working more than 3 days per week	10 (11·0%)	91 (14·4%)	0·39	4 (12·1%)	28 (15·1%)	0·79	0·78
Number with clinical YSR total problems score	10 (11·0%)	71 (11·0%)	0·99	4 (12·1%)	37 (19·8%)	0·30	0·003
Excessive drinking	10 (11·0%)	96 (14·9%)	0·32	8 (24·2%)	40 (21·4%)	0·72	0·009
Smoking	7 (7·7%)	91 (14·2%)	0·09	6 (18·2%)	52 (27·8%)	0·25	<0·0001
Used marijuana	1 (1·1%)	21 (3·3%)	0·51	1 (3·0%)	15 (8·0%)	0·47	0·004
Used MDMA	0 (0·0%)	4 (0·6%)	1·00	0 (0·0%)	2 (1·1%)	1·00	0·63
Used hypnotic or sedative	3 (3·3%)	18 (2·8%)	0·74	0 (0·0%)	10 (5·3%)	0·37	0·22

Data were missing for some adolescents regarding level of education (3), parental employment (11), ethnic background (18), and religion (30). *p= differences between affected school and the two control schools. †p= differences between total analysed group and total group lost to follow-up.

Table 1: Characteristics of participating adolescents

	Affected school (n=81)*		Control schools (n=633)*		Difference in change between groups		Intention to treat (affected school n=124; control schools n=830)	
	Before	After	Before	After	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)†	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)†
Clinical score								
Total problems	9 (11.1%)	19 (23.5%)	70 (11.1%)	96 (15.2%)	1.82 (1.01–3.29)	1.67 (0.88–3.20)	1.49 (0.85–2.60)	1.28 (0.70–2.36)
Internalising problems	5 (6.2%)	15 (18.5%)	59 (9.3%)	84 (13.3%)	1.71 (0.91–3.22)	1.70 (0.85–3.37)	1.46 (0.80–2.65)	1.31 (0.69–2.49)
Externalising problems	8 (9.9%)	15 (18.5%)	54 (8.5%)	87 (13.7%)	1.41 (0.76–2.64)	1.62 (0.82–3.22)	1.09 (0.59–1.99)	1.16 (0.61–2.23)
Withdrawn	2 (2.5%)	6 (7.4%)	15 (2.4%)	37 (5.8%)	1.30 (0.52–3.27)	1.40 (0.52–3.77)	0.99 (0.39–2.53)	0.97 (0.36–2.59)
Somatic complaints	5 (6.2%)	7 (8.6%)	34 (5.4%)	40 (6.3%)	1.39 (0.59–3.24)	1.64 (0.65–4.12)	1.32 (0.63–2.79)	1.45 (0.65–3.26)
Anxious or depressed	0 (0.0%)	8 (9.9%)	11 (1.7%)	27 (4.3%)	2.85 (1.23–6.61)	3.20 (1.26–8.09)	2.35 (1.03–5.37)	2.28 (0.93–5.58)
Social problems	3 (3.7%)	4 (4.9%)	34 (5.4%)	24 (3.8%)	1.41 (0.47–4.22)	1.56 (0.47–5.17)	1.27 (0.48–3.37)	1.07 (0.38–3.04)
Thought problems	6 (7.4%)	13 (16.0%)	51 (8.1%)	56 (8.8%)	2.16 (1.09–4.30)	2.54 (1.19–5.44)	1.78 (0.92–3.44)	2.06 (1.01–4.19)
Attention problems	3 (3.7%)	9 (11.1%)	16 (2.5%)	40 (6.3%)	1.81 (0.82–3.99)	1.96 (0.82–4.66)	1.45 (0.67–3.16)	1.52 (0.65–3.54)
Delinquent behaviour	0 (0.0%)	7 (8.6%)	16 (2.5%)	51 (8.1%)	1.20 (0.52–2.76)	1.74 (0.70–4.29)	1.01 (0.44–2.27)	1.27 (0.53–3.02)
Aggressive behaviour	1 (1.2%)	7 (8.6%)	17 (2.7%)	22 (3.5%)	3.30 (1.30–8.36)	3.71 (1.28–10.7)	2.78 (1.12–6.92)	2.76 (1.00–7.61)
Self destructive or identity problems‡	1 (3.1%)	2 (6.3%)	9 (2.8%)	18 (5.6%)	1.10 (0.24–5.13)	2.07 (0.37–11.7)	0.93 (0.20–4.39)	1.38 (0.27–7.11)

*In both groups, ten adolescents provided incomplete YSR data at the second measurement—before refers to those with complete YSR data both before and after the disaster and therefore slightly differ from those in table 1. †Adjusted for sex, age, level of education, ethnic background, and religion. ‡This score can only be calculated for boys; number of adolescents in analysed group are 32 and 319, for affected school and control schools, respectively; for intention-to-treat analyses, 46 and 428, respectively.

Table 2: **Outcomes for behavioural and emotional problems reported on the YSR**

per month, excessive use of alcohol as at least five drinks on one occasion in the preceding 2 weeks, and use of other psychoactive substances as use at least once ever.

Statistical analysis

Because of the nature of the study, we did not calculate power beforehand. We compared the adolescents of the affected school who provided follow-up data with those in control schools to look for changes between baseline and follow-up in all categories, using logistic regression. Next, we assessed whether the size of the changes was affected by sex or exposure to the disaster.^{2–5} We repeated all analyses, adjusting for background characteristics that were significantly different between affected and control schools (age, educational level, ethnic origin, religion, and parental employment). We also did an intention-to-treat analysis of data from all individuals, including those lost to follow-up. We assumed no change in those lost to follow-up since baseline. All p values are two-sided and have not been adjusted for multiple comparisons. We used χ^2 tests for all proportions except for when the expected counts were less than 5, in which case we used Fisher's exact test. For continuous data we used *t* tests, and F tests in ANOVA.

Role of funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit this report for publication.

Results

We received complete data for the baseline measurement from 954 adolescents, of whom 124 attended the affected school. Of these, 734 (77%) provided us with at least some follow-up data, with slightly fewer from the affected school (91 [73.4%]) than from the others (643 [77.5%], $p=0.31$). The figure shows participant flow and follow-up. Table 1 shows baseline characteristics of all adolescents. Demographic characteristics but not baseline values of outcome measures differed significantly between the affected school and control schools. Demographic differences were mostly due to real differences between the schools; eg, the affected school and one of the control schools were denominational—Roman Catholic and Protestant, respectively. We also analysed whether affected and control schools differed in loss to follow-up for characteristics that showed significant overall differences in loss to follow-up. We did this by assessing the interaction between school (affected or control) and follow-up status (analysed or lost to follow-up). None of these interactions were significant (range of p values: 0.08–0.95). Differences were thus not due to selective loss to follow-up, since loss to follow-up by characteristic did not differ between the affected school and control schools. The exposure to the fire was, however, much higher in the group lost to follow-up than in the analysed group. In the analysed group ($n=91$), 14 adolescents (15%) were present at the fire, of whom five (5%) were wounded; in the lost to follow-up group ($n=33$), these figures were 17 (52%) and 12 (36%), respectively (both $p<0.0001$), one of whom died.

	Affected school		Control schools		Difference in change between groups		Intention to treat (affected school n=124; control schools n=830)	
	Before	After	Before	After	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)†	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)†
Excessive drinking (87/634)*	9 (10.3%)	65 (74.7%)	95 (15.0%)	261 (41.2%)	4.57 (2.73–7.64)	5.09 (2.94–8.80)	2.96 (1.98–4.43)	3.19 (2.07–4.91)
Tobacco smoking (83/629)	6 (7.2%)	18 (21.7%)	89 (14.1%)	174 (27.7%)	0.87 (0.48–1.56)	0.88 (0.47–1.65)	0.81 (0.47–1.39)	0.84 (0.47–1.50)
Use of marijuana (85/634)	1 (1.2%)	10 (11.8%)	21 (3.3%)	83 (13.1%)	0.99 (0.48–2.02)	1.54 (0.71–3.33)	0.88 (0.44–1.77)	1.26 (0.60–2.63)
Use of MDMA (85/633)	0 (0.0%)	1 (1.2%)	4 (0.6%)	15 (2.4%)	0.49 (0.06–3.74)	1.21 (0.14–10.6)	0.43 (0.06–3.35)	0.72 (0.09–5.88)
Use of hypnotic or sedative (85/633)	2 (2.4%)	7 (8.2%)	17 (2.7%)	27 (4.3%)	2.03 (0.85–4.82)	1.96 (0.77–5.00)	1.66 (0.72–3.83)	1.73 (0.70–4.26)

*Number of respondents in affected school/control schools—before refers to those with data for every outcome both before and after the disaster. †Adjusted for sex, age, level of education, ethnic background, and religion.

Table 3: **Outcomes for smoking, excessive drinking, and use of marijuana, MDMA, and hypnotics or sedatives**

	Boys*				Girls*				p‡
	Odds ratio (95% CI)	p	Adjusted odds ratio (95% CI)†	p	Odds ratio (95% CI)	p	Adjusted odds ratio (95% CI)†	p	
Clinical score									
Total problems	1.01 (0.28–3.67)	0.99	1.09 (0.27–4.37)	0.91	2.15 (1.07–4.31)	0.031	1.99 (0.95–4.18)	0.07	0.23
Anxious or depressed	0.74 (0.09–5.84)	0.78	1.17 (0.13–11.0)	0.89	5.02 (1.81–13.9)	0.002	5.03 (1.65–15.4)	0.005	0.09
Thought problems	1.79 (0.57–5.63)	0.32	2.77 (0.72–10.6)	0.14	2.34 (0.97–5.64)	0.06	2.97 (1.13–7.87)	0.028	0.81
Aggressive behaviour	1.47 (0.30–7.28)	0.64	2.04 (0.31–13.5)	0.46	6.91 (1.92–24.8)	0.003	5.62 (1.41–22.5)	0.015	0.15
Excessive drinking	2.79 (1.25–6.23)	0.012	2.82 (1.19–6.68)	0.019	7.76 (3.94–15.3)	<0.0001	7.35 (3.60–15.0)	<0.0001	0.07

*Number of boys (affected school and control schools) for YSR outcomes 32 and 319, respectively, and for excessive drinking 33 and 323. Number of girls for YSR outcomes 49 and 314, respectively, and for excessive drinking 54 and 311. †Adjusted for age, level of education, ethnic background, and religion. ‡p value for interaction of school effect and sex.

Table 4: Differences in outcomes by sex, for adolescents of the affected school compared with those of the control schools

The proportion of adolescents with behavioural and emotional problems, as measured by the YSR, increased in all three schools (table 2). Increases were larger in the affected school than in the control schools for the total problems scale ($p=0.045$), and the anxious or depressed ($p=0.014$), thought problems (ie, incoherent thinking) ($p=0.028$), and aggressive behaviour ($p=0.012$) scales. These differences increased after adjustment for background characteristics in which the affected and control schools differed significantly, except for the differences in total problems score. Intention-to-treat analysis yielded lower effect estimates, with two remaining significant.

The proportion of adolescents using various substances increased (table 3). All increases were larger in the affected school than in the control schools, but differences were only significant for excessive drinking ($p<0.0001$). This result was also seen in the intention-to-treat analyses. A Bonferroni adjustment for comparisons of primary endpoints²⁰—YSR total problems score, smoking, and excessive use of alcohol—resulted in only alcohol use being significant.

All differences between the affected school and control schools were larger for girls than for boys, but none significantly so (table 4). Increases in outcomes did not differ significantly according to exposure to the disaster, although they were larger for Volendam adolescents who were present at the fire (table 5). It should be realised that this was for a small group.

Discussion

Our results show that adolescents exposed to a disaster undergo increases in self-reported anxiety, depression, thought problems, and aggression, and a large increase in self-reported excessive use of alcohol. Increases in all effects were larger in girls than in boys, and those in alcohol use were larger in adolescents who had been in the fire, but none of these differences was significant. This mostly confirms the evidence from studies with only postdisaster data,^{1–5} or with prospective pre-disaster and postdisaster data for an affected group but not for controls.^{8–11}

Selective loss to follow-up, imprecise information, and the effect of postdisaster interventions might have affected our findings, but would have led to an underestimation of effects. 220 (23.1%) adolescents (affected school 33 [26.6%]; control schools 187 [22.5%]) were lost to follow-up. The proportion of youngsters in the fire who were injured was much larger in those lost to follow-up than in the analysed group. These adolescents were, a priori, more likely to show adverse effects, which implies that we underestimated the effects of the disaster; and in the intention-to-treat analysis we entered all those lost to follow-up as if they still had their original baseline scores. We therefore explored an alternative to this intention-to-treat analysis. In this alternative, we assumed that those in the lost to follow-up group who were seriously wounded and hospitalised (six of the 17 who were in the fire) would all have developed mental health problems, and become smokers and excessive drinkers. Increases in the affected group would then be significantly higher for ten out of the 12 YSR outcomes (not for externalising and self-destructive or identity problems) as well as for excessive drinking. We could further hypothesise that adolescents who attend a café run an increased risk of excessive drinking, but our results show that this risk also increased for the other adolescents from the affected school.

Imprecision of the self-reported data might have affected our outcomes but this seems unlikely. Answers were confidential and anonymous, which has been shown to lead to valid self-reported information for use of alcohol²¹ and adolescent smoking.^{22,23} Questionnaire information about mental health also has good validity, compared with structured clinical interviews such as the diagnostic interview schedule for children.^{24,25} Moreover, any bias in outcome measures, if present, would affect both baseline and follow-up measurements in both groups. An additional difficulty could be that global measures for behavioural and emotional problems, such as the YSR, are insensitive to some of the specific effects of disaster on children and adolescents.² Our results indeed showed that the largest effects were in subscales that measure symptoms associated with disasters, such as anxiety and cognitive problems. We did not assess specific

	Not in café during disaster*				In café during disaster*				p†
	Odds ratio (95% CI)	p	Adjusted odds ratio (95% CI)‡	p	Odds ratio (95% CI)	p	Adjusted odds ratio (95% CI)‡	p	
Clinical score									
Total problems	1.87 (1.00–3.47)	0.049	1.78 (0.91–3.48)	0.09	1.50 (0.29–7.77)	0.63	1.03 (0.18–5.82)	0.97	0.80
Anxious or depressed	2.84 (1.17–6.88)	0.021	3.21 (1.23–8.37)	0.017	2.88 (0.35–23.7)	0.33	3.10 (0.34–28.2)	0.31	0.99
Thought problems	2.08 (1.00–4.34)	0.050	2.44 (1.10–5.42)	0.028	2.66 (0.50–14.2)	0.25	3.40 (0.60–19.4)	0.17	0.79
Aggressive behaviour	3.78 (1.48–9.64)	0.005	4.20 (1.47–12.0)	0.007	§		§		0.19
Excessive drinking	4.03 (2.36–6.88)	<0.0001	4.37 (2.48–7.69)	<0.0001	14.6 (1.99–112.3)	0.010	20.5 (2.59–161.4)	0.004	0.16

*Number of adolescents (not present and present) for YSR outcomes 71 and 10, respectively, and for excessive drinking 74 and 13. †p value for differences in odds ratio between adolescents who were present at the café fire and adolescents who were not. ‡Adjusted for sex, age, level of education, ethnic background and religion. §All adolescents who were present at the café fire scored in the normal range post-disaster.

Table 5: Differences in outcomes for non-exposed and exposed adolescents of affected school compared with adolescents of control schools

stress responses to disasters, including specific fears, intrusive thoughts, avoidance of reminders, or bereavement reactions.² Prospective pre-disaster data are unlikely to be available for these outcomes in any investigation. Moreover, the cut-offs used for dichotomising outcomes might have affected our results. Thus, we repeated all analyses with a lower cut-off point for the YSR, which almost doubled the number of students that had an increased score^{17,18} and a higher cut-off for substance use. Results were similar (not shown).

Finally, the immediate set-up of a treatment programme for all victims, both inside and outside the setting of this denominational school, might have reduced the effects of the disaster, though not much is known about the effectiveness of such treatment.^{26,27} If the treatment were effective, it would have led to underestimation of the effects and, in particular, would explain the rather similar outcomes for both groups of adolescents.

Postdisaster health care should be aimed at the physical and psychosocial consequences of disaster.^{26,28} Our results confirm the need for services to ameliorate the negative mental health effects of exposure to disaster, including anxiety, depression, incoherent thinking, aggression, and substance use,¹⁻⁵ which commonly occur in combination with post-traumatic stress disorder.^{5,6,29,30} In particular, the effects of the trauma on excessive use of alcohol were very large, and early interventions should include measures to prevent alcohol abuse. There is some, though limited, evidence^{31,32} that school-based prevention programmes,³²⁻³⁴ and selective preventive interventions for those who are at greatest risk,^{32,33} are effective in reducing substance use and alcohol misuse in adolescents. Evidence also supports the need to involve parents in these interventions.^{32,34} Our findings show that adolescents are inclined to react to severe stressful events with excessive use of alcohol. This might help policy-makers and researchers to incorporate prevention and treatment strategies to reduce excessive use of alcohol if a disaster involves adolescents, and to prevent alcohol dependence. Finally, our results confirm that the disaster affected girls more than boys,²⁻⁵ and those directly exposed to the disaster misused alcohol more than others,²⁻⁵ although differences were not significant because of the small numbers.

We might have underestimated the effects on those exposed to the disaster since many were lost to follow-up, possibly because of the effect the disaster had on them. Notwithstanding, effects were also large among those who had not been exposed to the disaster directly. Experiences such as the loss of classmates, friends, brothers and sisters, and the daily confrontation, both within and outside school, with those who survived but were severely injured, probably increased problems in this group. Our results stress the importance of actively including non-exposed adolescents in care after disasters.

Our results need confirmation in other situations, with other age groups of children and adolescents and with clinical assessments of mental health. These might also provide evidence for risk factors for the development of mental problems after trauma and exposure to trauma, such as pre-existent mental problems in individuals or their families,^{3,35-37} family disruption after the disaster,^{3,4} and genetic makeup.³⁶⁻³⁸

Contributors

S A Reijneveld had the original idea for the project, wrote the study protocol, and coordinated the study. All authors discussed the protocol and formulated the final design. M R Crone supervised the data collection. S A Reijneveld and M R Crone did the statistical analyses, which were discussed by all authors. S A Reijneveld wrote the final manuscript, which was discussed, edited, and revised by all authors.

Conflict of interest statement

None declared.

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