

Smoking as a Risk Factor for Mental Health Disturbances After a Disaster: A Prospective Comparative Study

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Objective: To assess whether smoking is a(n) (independent) risk factor for mental health problems among adult disaster victims and among a nonexposed comparison group.

Method: Surveys were conducted 18 months (T1) and 4 years (T2) after a fireworks disaster in Enschede, the Netherlands (May 13, 2000), among adult victims (N = 662) and a comparison group (N = 526) of residents of a city located in another part of the Netherlands. The surveys included measures of smoking (Dutch Local and National Public Health Monitor); severe anxiety, depression, and hostility symptoms (the Symptom Checklist-90, revised); and disaster-related post-traumatic stress disorder (PTSD; DSM-IV criteria) (the PTSD self-rating scale).

Results: Victims who smoked at T1 had a higher chance to suffer from severe anxiety symptoms (adjusted OR = 2.32 [95% CI = 1.19 to 4.53]), severe hostility symptoms (adjusted OR = 1.84 [95% CI = 1.06 to 3.22]), and disaster-related PTSD (adjusted OR = 2.64 [95% CI = 1.05 to 6.62]) at T2 than victims who did not smoke at T1, when controlling for symptoms at T1, demographic characteristics, and life events. Among the total comparison group, smoking was not an independent risk factor. However, smoking at T1 was associated with severe anxiety symptoms at T2 among controls who were confronted with stressful life events (adjusted OR = 4.11 [95% CI = 1.03 to 16.47]).

Conclusions: Smoking is an independent risk factor for severe anxiety and hostility symptoms and PTSD among adult disaster victims and for anxiety symptoms among adult people who are confronted with stressful life events. Questions about smoking behavior among disaster victims may help to identify adult victims who are at risk for postevent mental health disturbances.

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Posttrauma mental health disturbances such as post-traumatic stress disorder (PTSD) are associated with increased smoking,^{1–3} either by starting to smoke or an increase of tobacco use. However, very few trauma studies examined the reverse relationship, i.e., whether smoking is a risk factor for PTSD or other postevent mental health disturbances. For example, among survivors of the Herald of Free Enterprise disaster, smoking 6 months after this ferryboat disaster increased the risk for psychological distress, intrusions, and avoidance reactions 30 months postdisaster.⁴ After the September 11 terrorist attacks (2001), increased cigarette use (i.e., use 1 week before the attack compared to 1 week before the survey 5–8 weeks postdisaster) was positively associated with PTSD and depression 5 to 8 weeks postdisaster.³ Recently a twin registry study of male Vietnam veterans showed that nicotine dependency was independently associated with a 2-fold increased risk for PTSD.⁵ Although the validity of these important findings may be limited by the use of retrospective data about smoking⁵ and associations that were not adjusted for possible confounders,^{2,4} they warrant further investigation. As such, this research may add valuable information to identify victims who are at risk for postevent mental health disturbances.

Nevertheless, the outcomes of nontrauma studies suggest that the increased risk of mental health disturbances

associated with smoking is not restricted to traumatized people. Although using different samples (mainly among adolescents and young adults) and study designs, prospective studies have demonstrated that in general, smoking increases the risk of mental health disturbances, such as depression and panic.^{6,7} For example, a recent population-based prospective study⁸ found that the risk of depression within 11 years after baseline assessment was 4 times and 2 times as high for heavy and mild smokers, respectively, after controlling for demographic characteristics, life events, alcohol use, and general psychological distress at baseline. In a random sample of male Israeli military recruits not suffering from major psychopathology at baseline, a linear relationship was found between the number of cigarettes smoked and hospitalization for schizophrenia over a 4- to 16-year follow-up.⁹

The question arises whether or not smoking is associated with a higher risk for mental health disturbances among trauma-exposed people compared to the risk of smoking for these problems among a group of nonexposed people. In other words: is there a differential association between smoking and mental health disturbances? The aim of the present study is to examine whether smoking is a(n) (independent) risk factor for severe anxiety, depression, and hostility symptoms among a group of adult residents affected by a disaster and among a comparable group of nonexposed residents. Furthermore, we assessed whether smoking is associated with an increased risk for disaster-related PTSD among affected residents.

METHOD

Background

On May 13, 2000, a devastating explosion in a fireworks storage occurred in a residential area in the city of Enschede, the Netherlands. The disaster severely damaged or destroyed about 500 houses, killed 23 people, and injured over 900 victims. The Dutch government declared it a national disaster and decided to launch the comprehensive Enschede Fireworks Disaster Study.¹⁰⁻¹⁵

Procedure and Samples

Participants in this study were all of Dutch origin and gave their written informed consent. Their characteristics were described elsewhere in detail.¹¹⁻¹⁵ The Medical Ethical Committee of the Netherlands Organization for Applied Scientific Research (TNO; Zeist, the Netherlands) approved the study protocols.

The current research sample of adult victims consists of 662 affected residents who participated in 3 surveys after the disaster (2–3 weeks postdisaster, estimated response = 33%; 18 months postdisaster [November–December 2001], response = 80%; almost 4 years postdisaster [January–February 2004], response = 76%). Non-response analyses for the first survey revealed that the

prevalence rates of mental health problems at the first survey were not affected by the nonresponse.¹⁵ Furthermore, no significant differences in age; education; smoking; or anxiety, depression, and hostility symptoms were found between participants in the present study and all other participants who participated in the first survey (N = 421) but not in the second or third surveys. There was only a greater dropout of males ($\chi^2 = 9.12$, $df = 1$, $p < .01$).

Furthermore, the current study includes a comparison group of 526 adult nonexposed participants (i.e., controls, N = 526). They were residents of the city of Tilburg, located in another part of the Netherlands. They participated at the second (response = 61.0%) and third surveys (response = 78.5%) and were drawn from the Registry Office of the city of Tilburg, the Netherlands, in a comparable residential area (comparable in composition of the population and general health status) in Tilburg. Due to time constraints, we could not arrange a comparison group 2 to 3 weeks postdisaster. No significant differences in age or anxiety, depression, and hostility symptoms were found between controls in the present study and all other controls that participated in the second survey (N = 168). Controls with lower educational levels ($\chi^2 = 22.5$, $df = 3$, $p < .001$) and smokers ($\chi^2 = 7.12$, $df = 2$, $p < .05$) were more likely to be lost to follow-up.

In the present study, we focus on the surveys 18 months (T1) and almost 4 years (T2) postdisaster in order to be able to compare the risk of smoking for mental health disturbances among both groups, i.e., to keep the time between T1 and T2 (approximately 27 months) equal among both groups.

Measures

We assessed stressful life events (for example, death of a significant other, divorce, being a victim of crime) at T2. For the present study, we made a distinction between participants who reported 1 or more stressful life events 2 to 5 years before T2 and participants who reported none (approximately in the 3 years before T1).

To examine smoking (cigarettes, pipe, cigars) at both surveys, standardized smoking questions of the Dutch Local and National Public Health Monitor¹⁶ were applied (e.g., Do you ever smoke? 1 = yes; 2 = no, but in the past; 3 = no, I never smoked).

We administered the Symptom Checklist-90, revised (SCL-90-R),^{17,18} to assess depression symptoms (16 items), anxiety symptoms (10 items), and hostility symptoms (6 items) at T1 and T2. The validity and reliability of the Dutch SCL-90-R has proven to be fine. The Dutch cutoff scores for a normal population¹⁸ were used to identify participants with severe symptoms (scores at or above 8 deciles). The internal consistency of the SCL-90-R scales was very good (Cronbach's α , all above .89).

Disaster-related PTSD at T1 and T2 was assessed with the Posttraumatic Stress Disorder self-rating scale

Table 1. Smoking and Mental Health Disturbances Among Residents Affected by the Fireworks Disaster in Enschede, the Netherlands (May 13, 2000), and a Comparison Group at T1 and T2^{a,b}

Variable	Affected Residents (N = 662)		Comparison Group (N = 526)		χ^2	df	p
	N	%	N	%			
Smoking at T1					1.43	2	.49
Did not smoke at or before T1	197	29.9	167	31.9			
Did smoke before T1 ^c	212	32.2	152	29.0			
Did smoke at T1	250	37.9	205	39.1			
Smoking at T2					1.51	2	.47
Did not smoke at or before T2	194	29.5	161	30.8			
Did smoke before T2 ^c	244	37.1	176	33.6			
Did smoke at T2	220	33.4	186	35.6			
Severe anxiety symptoms at T1					38.8	2	< .001
No	472	73.5	462	88.3			
Yes	170	26.5	61	11.7			
Severe anxiety symptoms at T2					39.8	2	.028
No	522	80.7	444	85.5			
Yes	125	19.3	75	14.5			
Severe depression symptoms at T1					9.8	2	.002
No	446	69.6	406	77.8			
Yes	195	30.4	116	22.2			
Severe depression symptoms at T2					3.2	2	.074
No	480	74.7	409	79.1			
Yes	163	25.3	108	20.9			
Severe hostility symptoms at T1					6.4	2	.011
No	482	74.0	420	80.3			
Yes	169	26.0	103	19.7			
Severe hostility symptoms at T2					4.8	2	.026
No	506	77.9	432	83.1			
Yes	144	22.1	88	16.9			

^aT1 = survey in which both groups participated for the first time (18 months postdisaster); T2 = survey in which both groups participated for the last time (almost 4 years postdisaster).

^bNs vary due to missing data.

^cSubjects who smoked before but not during the time of the survey.

(SRS-PTSD),¹⁹ based on DSM-IV criteria. The SRS-PTSD (22 items; Cronbach's $\alpha > .89$) demonstrated a good balance between sensitivity (86%) and specificity (80%).²⁰

Statistical Analyses

To assess if smoking at T1 is a(n) (independent) risk factor for mental health disturbances at T2 among both groups, a series of logistic regression analyses was conducted. We began with separate bivariate logistic regression analyses. We examined crude odds ratios and 95% confidence intervals for mental health disturbances at T2 in relation to smoking at T1. Multivariate logistic regression analyses were conducted to examine the independent association of smoking on mental health disturbances. Covariates were demographic characteristics; severe depression, anxiety, and hostility symptoms at T1; and stressful life events 2 to 5 years before T2. SPSS version 13.0 (SPSS Inc., Chicago, Ill.) was used to perform statistical analyses.

RESULTS

Victims and controls did not differ significantly in gender (males: 42.7% and 44.3%, respectively), mean age (45.1 [SD = 14.9] and 44.6 [SD = 15.2] years, respec-

tively), mean educational level (2.7 [SD = 0.9] and 2.6 [SD = 0.9] grades, respectively), and reported stressful life events (1 or more) in the period 2 to 5 years before T2 (44.6% and 41.8%, respectively).

Two to 3 weeks postdisaster, 212 affected residents (32%) did not smoke, 186 (28.1%) smoked before the first survey, and 264 (39.9%) smoked at the time of the first survey. Furthermore, 266 survivors (41.8%) had severe anxiety symptoms, 283 (45.4%) had severe depression symptoms, and 275 (43.0%) had severe hostility symptoms.

Table 1 shows that smoking at T1 (18 months postdisaster) and T2 (4 years postdisaster) was not different between victims and control subjects. According to Table 1, 29.9% and 31.9% of the affected residents and control subjects, respectively, did not smoke at or before T1. At T2, 29.5% and 30.8%, respectively, did not smoke, indicating that a few nonsmokers at T1 began to smoke after T1. The percentages of participants in both groups who smoked before T2 but not at T2 (37.1% and 33.6%, respectively) were greater than the percentages of participants in both groups who smoked before T1 but not at T1 (32.2% and 29.0%, respectively), indicating that several participants in both groups quit smoking between T1 and T2. This is reflected in the decline of percentages in

both groups of smokers in both periods T1 and T2 (affected residents, T1: 37.9% and T2: 33.4%; comparison group, T1: 39.1% and T2: 35.6%).

At T1 and T2, 13.4% and 9.7%, respectively, of the victims met the criteria for PTSD according to the SRS-PTSD. According to the crude odds ratios shown in Table 2, those who smoked at T1 were more likely to suffer from severe symptoms at T2 than nonsmokers, regardless of being a victim of the disaster or not.

The adjusted odds ratios indicate that smoking at T1 was not a significant independent risk factor among the comparison group. Furthermore, smoking was not an independent risk factor for depression symptoms among the affected residents, and smoking before T1 was not independently associated with mental health disturbances at T2. However, smoking at T1 was independently associated with severe anxiety and hostility symptoms at T2 (see Table 2).

In addition, we examined whether smoking at T1 was associated with a greater risk for disaster-related PTSD at T2, adding disaster-related PTSD at T1 to the list of covariates (PTSD was not assessed among the comparison group). Victims who smoked at T1 were more likely to suffer from PTSD at T2 (16.1%) than victims who did not smoke at T1 (5.2%; adjusted OR = 2.64, 95% CI = 1.05 to 6.62, $p = .039$).

Since we found that smoking was independently associated with severe anxiety and hostility symptoms among victims but not among controls, we hypothesized that stressful life events moderated this association. We explored this hypothesis in 2 subgroups of controls: (1) control subjects who were confronted with stressful life events in the period 2 to 5 years before T2 ($N = 220$) and (2) control subjects who were not confronted with these events ($N = 306$). We repeated the multivariate logistic regression analyses. Among the subgroup with stressful life events, smokers at T1 were more likely to have severe anxiety symptoms (24.7% vs. 8.3%; adjusted OR = 4.11, 95% CI = 1.03 to 16.47, $p = .046$) at T2 than nonsmokers. There was a statistical trend ($.05 \leq p < .10$) that smokers were more likely to have severe hostility symptoms at T2 than nonsmokers (30.0% vs. 11.1%; adjusted OR = 2.80, 95% CI = 0.86 to 9.07, $p = .087$). Smoking was not independently associated with depression symptoms. As expected, within the subgroup of controls who did not report stressful life events, smoking was not a significant independent risk factor ($1.05 \leq OR \leq 1.13$).

DISCUSSION

Victims who smoked 18 months postdisaster were more likely to have severe anxiety and hostility symptoms and disaster-related PTSD 27 months later, even after controlling for existing symptoms (i.e., symptoms at T1), demographic characteristics, and life events. These

Table 2. Crude and Adjusted Odds Ratios for Smoking at T1 Associated With Mental Health Disturbances at T2 Among Affected Residents and Comparison Group^a

Variable	Affected Residents (N = 662)				Comparison Group (N = 526)			
	No. With Symptoms/Total, N/N (%)	Crude OR (unadjusted)	Adjusted OR ^b	95% CI	No. With Symptoms/Total, N/N (%)	Crude OR (unadjusted)	Adjusted OR ^b	95% CI
Severe depression symptoms at T2								
Did not smoke at T1 ^c	41/190 (21.6)	1	1		24/164 (14.6)	1	1	
Did ever smoke before T1	48/206 (23.3)	1.10	0.67	0.37 to 1.21	29/148 (19.6)	1.42	0.78	0.37 to 1.66
Did smoke at T1	73/244 (29.9)	1.55*	1.05	0.60 to 1.84	54/203 (26.6)	2.11*	1.16	0.60 to 2.23
Severe anxiety symptoms at T2								
Did not smoke at T1 ^c	22/191 (11.5)	1	1		15/164 (9.1)	1	1	
Did ever smoke before T1	39/207 (18.8)	1.78*	1.29	0.64 to 2.59	17/150 (11.3)	1.27	0.54	0.20 to 1.44
Did smoke at T1	63/246 (25.6)	2.64*	2.32*	1.19 to 4.53	42/203 (20.7)	2.59*	1.64	0.73 to 3.68
Severe hostility symptoms at T2								
Did not smoke at T1 ^c	30/193 (15.5)	1	1		17/164 (10.4)	1	1	
Did ever smoke before T1	39/209 (18.7)	1.25	0.84	0.46 to 1.55	23/149 (15.4)	1.58	0.93	0.40 to 2.17
Did smoke at T1	74/245 (30.2)	2.35*	1.84*	1.06 to 3.22	47/205 (22.9)	2.57*	1.56	0.76 to 3.19

^aT1 = survey in which both groups participated for the first time (18 months postdisaster); T2 = survey in which both groups participated for the last time (almost 4 years postdisaster).
^bOdds ratios adjusted for (1) demographic characteristics; (2) severe depression, anxiety, and hostility symptoms at T1; and (3) life events in the period 2 to 5 years before T2.
^cReference group.
^{*} $p < .05$.

results substantiate the findings of previous trauma studies.^{3,4,5}

Within control subjects, smoking predicted severe symptoms, but after controlling for existing symptoms, demographic characteristics, and life events, the odds ratios decreased and were no longer significant. Our results are consistent with the findings of the 5-year longitudinal study of Breslau et al.²¹; the odds ratio for major depression associated with daily smoking was significant, but controlling for early conduct problems and T1 history of alcohol use disorder reduced the relative risk for major depression. In contrast to the recent prospective study of Klungsøyr et al.,⁸ smoking among control subjects was not independently associated with a higher risk for severe symptoms at follow-up. Differences in data collection methods (retrospective collected data about depression vs. current symptoms at both surveys), time frame (11-year vs. 27-month interval), and control variables (general distress vs. specific symptoms) might account for the different results observed. In accordance with Vlahov et al.,³ smoking was a predictor for severe depression symptoms. However, our results showed that smoking is not an independent predictor for severe depression symptoms at T2 after controlling for symptoms at T1, demographic characteristics, and life events.

Important is, of course, the issue of the causal mechanisms behind the findings. With respect to trauma, Koenen et al.⁵ concluded that most, but certainly not all, of the PTSD–nicotine dependency association was explained by shared genetic factors. Nicotine facilitates the release of crucial neurotransmitters and hormones like cortisol. Heavy smoking almost permanently stimulates the sympathetic nervous system.²² A traumatic stressor with its associated neurobiological activation²³ might therefore have more impact on smoking individuals. Furthermore, smoking may be a coping mechanism to reduce distress caused by the traumatic or stressful event and thereby may affect the neuroendocrine stress response.^{3,22–27} This may explain the differences between victims and controls, and our explorative finding that controls who were confronted with stressful life events in the past and smoked at T1 were more at risk for severe anxiety symptoms at T2 than nonsmoking control subjects.

Our study has 3 key strengths: a prospective design, a comparison group, and an adjustment of the association between smoking and disturbances by controlling for current symptoms at T1. However, some limitations should be noted that might have influenced the generalizability of the results. First, participants were Dutch native residents of 18 years and older. Therefore, our results need replication in other (trauma) samples. The participation rate of the affected residents at the first survey was relatively low (estimated response = 33%). However, we have no indications that the nonresponse of the survivors affected the prevalence rates of mental health distur-

bances at the first survey.¹⁵ The response at T1 of the survivors (80%) was higher than the response of the comparison group (61%). On the other hand, the response of the comparison group at T2 (79%) was comparable with the response of the affected residents at T1 and T2 (80% and 76%, respectively). This indicates that when people began to participate in our longitudinal study, a large majority participated at follow-up.

There was a greater loss to follow-up of smokers in the comparison group. Since there was more loss to follow-up among control subjects with a low education level and smoking is positively associated with low education ($\chi^2 = 22.3$, $df = 6$, $p = .001$), we assume that the greater loss to follow-up of smokers is caused by the greater dropout of control subjects with a lower education level. However, victims and control subjects in the present study did not differ in demographic characteristics; reported life events; and the proportion of nonsmokers, ever-smokers, and smokers at T1 and T2. In the present comparative study, we focused on the period 18 months to 4 years postdisaster in order to be able to compare the risk of smoking for mental health disturbances between both groups (with the same approximately 27-month time interval). Due to time constraints we were not able to organize a comparison group 2 to 3 weeks postdisaster.

Second, the prevalence rates of PTSD may have been affected by the loss to follow-up, although nonresponse analyses showed no differences in intrusions and avoidance reactions (symptoms of PTSD) 2 to 3 weeks after the disaster (data not presented). However, it is possible that the relation between smoking and mental health disturbances among the participants in the present study differs from the relation among participants who did not participate at the follow-up surveys. Third, we have no predisaster information on smoking. Our findings might be a result of another unmeasured “third” factor, such as preexisting mental disorders or neuroticism, although we controlled for existing severe depression, anxiety, and hostility symptoms at T1. Furthermore, within the group of victims we also controlled for PTSD at T1 to assess the association between smoking and PTSD at T2. Fourth, in our study we focused on self-reported severe symptoms and PTSD. It is unclear whether clinical assessments would have led to other associations between smoking and mental health disturbances. We did not assess PTSD in the comparison group.

Despite these limitations, our findings and the results of previous studies clearly indicate that smoking is an important and promising risk factor for mental health disturbances after a traumatic event and suggest that smoking also increases the risk for anxiety symptoms after other stressful life events.

As such, questions about smoking behavior among disaster victims may help to identify disaster victims who are at risk for postevent mental health disturbances. This

study and previous studies add valuable information for the early detection of victims who develop or suffer from severe mental health problems after a disaster, in addition to variables such as predisaster psychopathology²⁸ and self-coping efficacy.²⁹ This information is useful not only for professionals who participate in a postdisaster mental health care program, but also for general practitioners and other professionals who have survivors in their patient population.

Furthermore, results and previous research suggest that a smoking cessation program should be offered to smoking survivors as an integrated part of a mental health care program after an event.^{2,30} However, smoking cessation may aggravate mental health disturbances, because smoking may be a coping mechanism to reduce distress. Nevertheless, in the study of McFall and colleagues,³⁰ smoking cessation was not associated with worsening symptoms of PTSD or depression.

In addition, our results showed that survivors who smoked in the past were not more at risk for mental health problems at T2 than nonsmokers. If our findings are replicated in future studies, this may suggest that disaster victims who smoke have the opportunity to reduce the risk for postevent mental health disturbances when they quit their smoking behavior after the disaster. There are all kind of leaflets and fact sheets available for disaster victims. Perhaps the advice to stop smoking or information about the possible effects of smoking on their mental health should then be added to these leaflets. Supplying victims with this information may enhance their own efforts to cope with the adverse effects of the event and regain control over their lives.

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