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Smoking predicts posttraumatic stress symptoms among rescue workers: A prospective study of ambulance personnel involved in the Enschede Fireworks Disaster

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Abstract

Background: Examining whether smoking is a risk factor for posttraumatic stress disorder (PTSD) symptoms among rescue workers affected by a disaster.

Methods: Ambulance personnel ($N=66$) participated in surveys 2–3 weeks (T1) and 18 months after a fireworks disaster (T2). Hierarchical multiple regression analyses were conducted with cigarette consumption at T1 as a predictor of PTSD symptoms at T2. Demographic characteristics, disaster experiences, peritraumatic dissociation, intrusions and avoidance, psychological distress and alcohol consumption assessed at T1 were included as covariates.

Results: Regression analyses showed that smoking at T1 independently predicted intrusions, avoidance, hostility, and depression symptoms at T2. Results were not affected by controlling for post-disaster critical incidents at work.

Conclusions: This is the first prospective study among rescue workers demonstrating that smoking soon after a disaster predicts PTSD symptoms in the intermediate term. Findings substantiate results of previous studies indicating that smoking is a relevant risk factor. Future research on how changes in cigarettes consumption post-trauma affect risk of PTSD is required.

Keywords

Disaster; Prediction; PTSD symptoms; Smoking; Ambulance personnel

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Conflicts of interest
None.

1. Introduction

In a comprehensive review, Feldner et al. (2007) concluded that there is general consensus across empirical studies that exposure to traumatic events and posttraumatic stress disorder (PTSD) are associated with increased smoking. For example, in the U.S. approximately 45% of persons with current PTSD are current smokers, in contrast to 22% of the general population (Feldner et al., 2007).

However, emerging evidence also suggests that smoking may influence occurrence of PTSD symptoms. Joseph et al. (1993) showed that increased smoking after a shipping disaster was positively related to psychological distress and intrusions and avoidance 30 months post-disaster. Vlahov et al. (2002) found that increased smoking was positively associated with PTSD and depression 5–8 weeks after the 11th September terrorist attacks. Increased smoking since September 11 was associated with disaster-related PTSD assessed at 4 months (Nandi et al., 2005), and 6–9 months post-attack (Vlahov et al., 2004). Similarly, Koenen et al. (2005) found that nicotine dependence among male Vietnam veterans was independently associated with a twofold risk for developing PTSD. Van der Velden et al. (2007), using data from the Enschede Fireworks Disaster Study, found that smoking 18 months post-disaster was independently associated with a 2–3-fold increased risk for PTSD 4 years post-disaster among affected residents.

The current prospective study also uses data from the Enschede Fireworks Disaster Study (Cf. Van Kamp et al., 2005; Van der Velden et al., 2006) to examine whether smoking independently predicts posttraumatic stress symptoms among rescue workers, i.e. ambulance personnel affected by this disaster. Previous studies suggest that rescue workers are at less risk of developing post-disaster mental health problems than affected citizens (Galea et al., 2005; Van der Velden et al., 2006). If smokers are at increased risk of developing PTSD symptoms, this information may help to identify affected rescue personnel who are most at risk for post-disaster mental health problems.

This longitudinal study started 2–3 weeks after the disaster (May, 2000, The Netherlands), causing the death of 23 people, injured approximately 1000 people, and destroyed 500 homes. The prospective study design enabled us to control for numerous pre- (age, gender, education), peri- (disaster exposure, peri-traumatic dissociation) and post-disaster variables (intrusions, avoidance, psychological distress, and alcohol consumption 2–3 weeks post-disaster), which may confound the relationship between smoking and PTSD symptoms (Brewin et al., 2000; Ozer et al., 2003; Stewart, 1996). In addition, we controlled for work-related post-disaster critical incidents. Of course, we were unable to control for all plausible confounders. In particular, absence of data on pre-disaster smoking is a limitation of this study that makes it difficult to study reciprocal relationships between smoking and PTSD that may be of interest.

2. Methods

2.1. Procedure and participants

Details on the procedures and measures of the Enschede Fireworks Disaster Study have been published previously and are briefly described here (Van Kamp et al., 2005; Van der Velden et al., 2006, 2007). The Medical Ethical Testing Committee (TNO, the Netherlands) approved the study protocols.

The present study group consisted of affected ambulance personnel ($N=66$), assessed 2–3 weeks (T1, estimated response between 31% and 49%) and 18 months post-disaster (T2; response = 83.5%). All participants gave their written informed consent. Data on affected

ambulance personnel have not been published previously. Therefore, we present the characteristics of the participants in Table 1.

2.2. Measures

2.2.1. Predictors—Smoking questions from the Dutch Local and National Public Health Monitor (GGD, 2003) were used to assess daily cigarettes consumption (CC) at T1 (number of cigarettes smoked). The number of cigars smoked was added to the number of cigarettes smoked (1 cigar was counted as 3 cigarettes).

2.2.2. Outcomes and Covariates—Disaster exposure was assessed at T1 using a list of 31 items (Van der Velden et al., 2006) about what rescue workers had seen, felt, heard or smelt during or immediately after the disaster (0 = no, 1 = yes). Items are summed to give a total disaster exposure score ($\alpha = 0.95$). Self-sustained injuries and death of a significant other were also assessed [1 = no (severe) self-sustained injuries/no loss significant other; 2 = severe injuries and/or loss significant other)].

The 10-item Peritraumatic Dissociative Experiences Questionnaire (Marmar et al., 1997) was administered at T1 to assess dissociation during or shortly after the disaster. Item response options ranged from 1 = not at all to 5 = often ($\alpha = 0.90$). Peritraumatic dissociation (PD), i.e. experiencing changes or distortions in the perception of time, space and the self, during or immediately after a traumatic event, is considered a risk factor for PTSD symptomatology (Cf. Ozer et al., 2003).

The SCL-90-R (Derogatis, 1977; Arrindell and Ettema, 1986) was administered to assess psychological distress at T1 (sum score of all 90 items), and hostility (6 items) and depression symptoms (16 items) at T2. Item response options ranged from 1 = not at all to 5 = extremely (all alphas ≥ 0.81).

The 15-item Impact of Event Scale (Horowitz et al., 1979; Van der Ploeg et al., 2004) was used at both waves to assess disaster-related intrusions and avoidance (0 = not at all, 5 = often; all alphas ≥ 0.86). Intrusions (e.g. re-experiencing the trauma) and avoidance (e.g. avoiding reminders of the trauma) are typical after a traumatic event and, in addition to hyperarousal, symptoms of PTSD.

Standardized alcohol consumption questions from the Dutch Monitoring Project on Risk Factors for Chronic Diseases (MORGEN-project, Blokstra et al., 1998) were applied at T1 (five categories: beer, red wine, white wine, sherry, and brandy; 0 = not to 4 = daily consumption). For the present study the total score of the five categories was calculated.

Ten items of the Acute Stress List (Van der Velden et al., 2006) were administered at T2 to measure critical incidents at work in the prior 12 months, including items such as “how many times were you involved in an accident which severely injured a child”. The total score was calculated by summing the 10 items. Response options ranged from 1 = not at all to 7 = daily ($\alpha = 0.72$).

2.3. Data analysis—Hierarchical multiple regression analyses were conducted to assess the relationship between smoking at T1 and PTSD symptoms at T2. At step 1 all pre-, peri and post-disaster T1 variables were entered as predictors, except cigarettes consumption (CC) at T1. At step 2 CC at T1 was added. Dependent variables at T2 were PTSD symptoms and included intrusions, avoidance, hostility, and depression. Analyses were performed by SPSS (version 14.0).

3. Results

Table 1 presents the results of step 2 of the regression analyses¹, with standardized beta's (β), t and p -values, zero-order and partial correlations between predictors and PTSD symptoms. CC at T1 independently predicted intrusions at T2 (step 2 $F^{\text{change}}(1, 49) = 5.9, p = 0.019, \Delta R^2_{\text{adjusted}} = 0.06$; total $R^2_{\text{adjusted}} = 0.44$), avoidance at T2 (step 2: $F^{\text{change}}(1, 49) = 4.9, p = 0.031, \Delta R^2_{\text{adjusted}} = 0.06$; total $R^2_{\text{adjusted}} = 0.30$), hostility symptoms at T2 (step 2: $F^{\text{change}}(1, 49) = 6.8, p = .012, \Delta R^2_{\text{adjusted}} = 0.08$; total $R^2_{\text{adjusted}} = 0.31$), and depression symptoms at T2 (step 2: $F^{\text{change}}(1, 49) = 4.4, p = .032, \Delta R^2_{\text{adjusted}} = 0.04$; total $R^2_{\text{adjusted}} = 0.52$). Multicollinearity between CC and predictors was evaluated before performing step 2 (VIF = 1.22, tolerance = 0.82).

Respondents were often confronted with post-disaster critical incidents at work (Mean = 30.3, S.D. = 10.2). For example, on a monthly basis, 57.6% reported failed reanimations and 6.1% encountered dead children. Entering post-disaster critical incidents in the full models of Table 1, did not alter our findings (data not shown in a table)¹.

4. Discussion

Before discussing our findings, we re-direct attention to limitations mentioned in our introduction, as well as other limitations faced in post-trauma observational research of this type, including the low T1 participation level. Despite these limitations to our knowledge, this is the first prospective study assessing smoking as a risk factor for PTSD symptoms among rescue workers. Consistent with studies of veterans and civilians affected by disasters (Koenen et al., 2005; Nandi et al., 2005; Joseph et al., 1993; Van der Velden et al., 2007; Vlahov et al., 2002, 2004) results show that there is an independent relationship between cigarettes consumption 2–3 weeks post-disaster and PTSD symptoms 18 months later. Thus, assessment of smoking may help to identify people who are at risk for PTSD symptoms after a traumatic event.

The biological mechanism underlying the smoking-PTSD association is not understood but may operate via the effects of smoking on the central nervous system. There is significant evidence that chronic smoking can produce dysregulation of the hypothalamic-pituitary-adrenal (HPA) system. Evidence from animal models suggests that drug abuse and stress trigger similar changes in midbrain dopaminergic function (Saal et al., 2003). Significant evidence suggests chronic smoking produces a dysregulation of neural stress systems (e.g., hypersecretion of cortisol). Constituents of tobacco smoke inhibit the enzymes involved in the breakdown of monoamines, including dopamine, serotonin and norepinephrine (Fowler et al., 2003), an effect that appears to normalize following successful smoking cessation (Rose et al., 2001). Indeed, chronic smoking may act to sensitize neurobiological stress response systems (Kassel et al., 2003). These neurobiological alternations might enhance vulnerability to developing PTSD symptoms following trauma exposure.

The strengths of the study include its prospective design and ability to control for relevant potential confounders of the smoking-PTSD association. However, the response level at T1 was not high (between 31% and 49%); participation at T2 was much improved (84%). We have no information on non-responders at T1. Furthermore, no information was available about smoking behavior before the disaster or the use of other drugs such as cannabis. We assessed self-reported PTSD symptoms and did not conduct clinical interviews to obtain diagnostic data. We controlled for relevant pre-, peri- and post-disaster factors (Brewin et al., 2000; Ozer et al., 2003), such as peritraumatic dissociation, disaster exposure, psychological distress, and

¹Models not presented here are available from the primary author on request.

alcohol consumption at T1. However, our findings might be confounded by other unmeasured “third factors” such as pre-existing mental health problems (Dirkzwager et al., 2006) and coping self-efficacy (Benight and Bandura, 2004). On the other hand, it is also possible that cigarette consumption was one of the unmeasured “third factors” in other trauma studies. Further research is warranted to examine whether our results will generalize to other groups of rescue workers.

Findings suggest that smoking might function as an independent causal determinant for post-disaster PTSD symptoms. Like prior studies, results raise the question whether the risk for PTSD symptoms can be attenuated by quitting or reducing cigarette consumption after the event (Koenen et al., 2005; Van der Velden et al., 2007). The relatively small number of respondents in our study prevented us from conducting additional analyses, such as assessing PTSD symptoms among respondents who reduced or increased cigarette consumption in the period between the T1 and T2 assessments. Therefore, future research on how changes in cigarette consumption post-trauma affect risk of PTSD is required. Since rescue workers are frequently exposed to traumatic events, there is opportunity for prospective studies that include measures of pre-event functioning. These studies are feasible and warranted.

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Appendix A

See Table A.1.

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Characteristics affected ambulance personnel ($N = 66$) and summary results hierarchical multiple regression analyses predicting posttraumatic stress symptoms (step 2)

M (S.D.) (%) Posttraumatic Stress Symptoms 18 months post-disaster															
	Intrusions			Avoidance reactions			Hostility symptoms			Depression symptoms					
	β	t	p	Partial ^a	β	t	Partial ^a	β	t	Partial ^a	β	t	Zero-order ^a	Partial ^a	Zero-order ^a
Age	38.2 (9.4)	0.07	0.72	0.47	0.22	0.10	0.03	0.03	0.29	0.78	0.19	0.04	0.13	0.04	0.00
Gender (females)	21.2	-0.20	-1.78	0.08	-0.08	-0.25	-0.14	-0.16	-1.14	0.26	-0.09	-0.16	0.18	0.20	0.19
Educational level ^b	2.9 (0.8)	-0.16	-1.48	0.15	-0.12	-0.21	-0.13	-0.15	-1.10	0.28	-0.15	-0.15	-0.17	-0.20	0.18
Disaster exposure	10.4 (8.0)	0.25	2.02	0.05	0.32	0.28	0.20	0.20	1.44	0.16	0.20	0.20	0.17	0.18	-0.23
Peritraumatic dissociation ^c	16.1 (7.1)	0.01	0.04	0.97	0.46	0.00	0.28	0.22	1.62	0.11	0.51	0.22	-0.45	-0.36	-0.04
Injuries/death due to disaster (yes)	7.7	0.13	1.24	0.22	0.21	0.17	0.02	0.02	0.13	0.90	0.05	0.02	0.02	0.03	-0.02
Intrusions at T1 ^d	11.8 (9.3)	0.06	0.39	0.70	0.45	0.05	-0.16	-0.13	-0.89	0.38	0.27	-0.13	-0.17	-0.14	0.29
Avoidance reactions at T1 ^d	6.3 (7.6)	0.36	2.37	0.02	0.54	0.32	0.36	0.29	2.12	0.04	0.45	0.29	0.13	0.11	0.53
Psychological distress at T1 ^e	106.2 (29.0)	0.14	0.78	0.44	0.49	0.12	0.01	>0.01	0.03	0.97	0.38	>0.01	0.73	0.46	0.60
Alcohol consumption at T1 ^f	3.8 (3.2)	-0.03	-0.27	0.79	-0.16	-0.04	-0.01	-0.02	0.11	0.91	-0.13	-0.02	0.11	0.14	-0.17
Cigarette consumption at T1 ^g	5.4 (8.7)	0.26	2.42	0.02	0.34	0.33	0.26	0.30	2.22	0.03	0.35	0.31	0.12	0.35	0.35

T1: assessed 2–3 weeks post-disaster.

^aCorrelations.

^bEducational level: (1) Elementary school (1.5%); (2) Junior high/middle school (28.6%); (3) High school level (44.4%); (4) College degree/university (25.4%).

^cPeritraumatic Dissociative Experiences Questionnaire.

^dImpact of events scale.

^eSymptom Checklist SCL-90-R.

^fDutch monitoring project on risk factors for chronic diseases.

^gDutch local and national public health monitor.

Table A.1
Course of health problems and cigarettes consumption

	2-3 weeks post-disaster		18 months post-disaster		<i>t</i>	d.f.	<i>p</i>
	M	S.D.	M	S.D.			
Intrusions ^a	11.8	9.3	4.0	5.8	7.5	63	0.000
Avoidance reactions ^a	6.3	7.6	3.1	5.3	3.6	63	0.001
Psychological distress ^b	106.2	29.0	102.6	20.0	1.3	63	ns
Depression symptoms ^b	19.4	6.2	18.4	4.4	1.5	63	ns
Hostility symptoms ^b	6.9	1.7	6.6	1.4	1.2	64	ns
Cigarette consumption ^c	5.4	8.7	4.5	7.6	1.3	65	ns

At 2-3 weeks and 18 months post-disaster, 79 and 66 ambulance personnel respectively participated. In total, 66 participated at both waves.

^aImpact of Events Scale.
^bSymptom Checklist SCL-90-R.
^cDutch Local and National Public Health Monitor.