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Consumption of Cigarettes, Alcohol, and Marijuana Among New York City Residents Six Months After the September 11 Terrorist Attacks

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ABSTRACT

Early analyses following the September 11 terrorist attacks on New York City showed an increase in cigarette, alcohol, and marijuana use, but it was unknown whether these increases would persist. A random-digit dial phone survey was conducted to estimate the prevalence of increased substance use among residents of New York City six to nine months after the attacks. Among 1570 adults, 9.9% reported an increase in smoking, 17.5% an increase in alcohol use, and 2.7% an increase in marijuana use compared to the month before September 11. These increases were comparable to increases reported in the first one to two months after September 11. Persons who increased use of cigarettes were more likely than those who did not to report symptoms consistent with posttraumatic stress disorder (PTSD) in the past month (4.3% and 1.2% respectively). Depression was more common among those who increased use of cigarettes (14.6% and 5.2% respectively), alcohol (11.8% vs. 5.2%), and marijuana (34.1% vs. 5.3%). Among residents living in Manhattan below One Hundred Tenth Street, the prevalence of PTSD and depression declined by more than half in the first six months after September 11, while the increase in substance use did not decline substantially. These results suggest that the increase in substance use after a disaster may be a cause for public health concern in the long-term.

Key Words: Cigarette smoking; Alcohol; Marijuana; Substance use; Disaster; Posttraumatic stress disorder.

INTRODUCTION

Numerous studies have shown that disaster survivors bear a substantial burden of mental health problems (1). Posttraumatic stress disorder (PTSD), depression, anxiety, and panic disorders are the most frequently documented psychological sequelae of disasters and mass trauma (2,3). The terrorist attacks of September 11, 2001, were the largest ever human-made disaster in the United States. In New York City alone, 2726 people died and a large area of lower Manhattan was destroyed in the attacks. The attacks have had a significant social and economic impact on New York City with increased unemployment, disruption of transportation, and the ongoing threat of further terrorist attacks. Early studies of the acute psychological effects after the September 11 attacks suggested a high prevalence of stress, PTSD, and depression throughout the United States and particularly in Manhattan (4,5). Follow-up studies suggest that there was substantial resolution of population-based PTSD and depression among New York City residents six months after September 11 (6).

Substance use is a well-documented co-morbid factor accompanying PTSD and other psychological disorders (7–9). However, few investigations have specifically documented the prevalence of increased substance use after major disasters. Most of the research on substance use after disasters has focused on direct survivors of the disaster, that is, people who were in some way directly affected by the event (10–13). However, persons in a community exposed to a large-scale disaster may be affected to different degrees by the disaster event, i.e., by being present at the disaster site, through relationships with victims, disruption of personal routines, or through repeated exposure to the event through the media, suggesting that persons in the general population may also experience psychological consequences, and potentially attendant elevations in substance use after a disaster. In addition, different measures of substance use and different postdisaster time frames make generalization of results from extant studies difficult. More comprehensive measurement of the effects of disasters on population substance use is needed for public health planning.

In earlier reports (14), we reported increased prevalence of cigarette, alcohol, and marijuana use in the general population of Manhattan living south of One Hundred Tenth Street one to two months after September 11 and reported that consumption of substances remained elevated six to nine months after the event (15). Here we report the correlates of increased consumption of substances in New York City six to nine months after September 11. We had three a priori hypotheses: 1) any continued increase in substance use six to nine months after the disaster would co-occur with PTSD and depression related to the September 11 attacks; 2) there would be an association between different event exposures and persistent increased substance use, and 3) consistent with our follow-up report suggesting substantial resolution of PTSD and depression among New York City residents over time (6), there would be reductions since the first assessment in the proportion of the population reporting increased substance use after the attacks.

METHODS

Sample

We conducted two random digit dial (RDD) household telephone surveys that included measures of substance use. The first survey was carried out between October 15 and November 16, 2001, and the second survey was carried out between March 25 and June 25, 2002. The sampling frame for the October–November survey was adult residents (18 years of

age or older) of Manhattan living south of One Hundred Tenth Street. This area, the part of New York City closest to the World Trade Center (WTC) site of the terrorist attacks, was selected in order to provide a rapid needs assessment in the areas most likely affected by the September 11 attacks. The sampling frame for the March–June survey included all adults in the New York City metropolitan area with oversampling of residents of Manhattan south of One Hundred Tenth Street to permit comparison between surveys. We limit our presentation of results from the second survey to New York City for these analyses.

The overall cooperation rate for the surveys was 64.3% for the initial survey, and 60.0% for the New York City sample of the six to nine month survey. Sampling weights were developed and applied to our data to correct potential selection bias related to the number of household telephones, persons in the household, and oversampling. Further discussions of the methods and results from the first of these surveys can be found elsewhere (6,14).

Data Collection

Trained staff conducted all interviews using a computer-assisted telephone interview (CATI) system. Interviews were available in English and Spanish for the first two surveys and further extended to include Chinese for the second survey. Native English, Spanish, Mandarin, and Cantonese speakers administered the interviews in the respective languages. All three surveys were approximately 35 minutes long and the measures used were consistent between surveys to allow for comparison. A protocol was in place to assist participants who requested mental health counseling in each of the surveys. The Institutional Review Board of the New York Academy of Medicine approved these studies.

In both surveys, respondents were asked questions using a structured questionnaire. The primary outcome variables for this analysis are increases in participants' cigarette smoking, alcohol drinking, and marijuana smoking. For each of the three substances we asked the following series of questions. First we asked if the participant had ever used the substance (e.g., "Have you ever smoked cigarettes?"). Participants who answered Yes to this question were asked how many cigarettes they smoked during the month before September 11. We asked about number of cigarettes smoked, number of drinks consumed, and number of times marijuana was smoked. In the second survey, we then asked number of times participants consumed each substance during the month the survey was conducted; in the first survey, we confined the time interval to the previous week. Therefore, we obtained measures of pre-September 11 substance use and post-September 11 substance use. For the analyses we examined increases in each of these substances individually.

The remainder of the survey instrument was based on items from previous surveys that assessed the mental health consequences of natural disasters (16). Demographic variables included age, race/ethnicity, gender, yearly household income, education, and marital status. We assessed proximity to the disaster site by collecting information about where the respondent was living prior to September 11 and where the respondent was upon hearing about the September 11 attack. We asked about a range of September 11 event-experiences including: if the respondents had witnessed the attacks of September 11, if the respondent was afraid for her/his life during the attacks, if friends or relatives were killed during the attacks, if the respondent was displaced from home as a result of the attacks, if the respondent was involved in the rescue efforts, and if the respondent lost a job or possessions as a result of the September 11 attacks. We measured peri-event panic attack using a modified version of the Diagnostic Interview Schedule (DIS) for panic attack (phrased to detect symptoms that happened during or shortly after the September 11 terrorist attacks) (17). We asked about panic symptoms specifically in the first few hours after the events of September 11. The presence of four or more symptoms contributed to a diagnosis of peri-event panic attacks. In addition, we assessed prior stressors, stressors since September 11, and current supports. We assessed recent stressors and asked about a list of eight traumatic events (e.g., having a spouse die) that the respondent had experienced in their lifetime before September 11, 2001. We also used a modified version of a standard scale to measure level of social support (18).

We used two measures of mental health status: PTSD and major depression. The PTSD measure was a modified version of the National Women's Study (NWS) PTSD Module (19), based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (20). The PTSD scale used has a sensitivity of 98.8% and a specificity of 79.1% (19,20). Further details of the PTSD and depression measures used is provided elsewhere (6,22).

Statistical Analyses

We report the use of each of cigarettes, alcohol, and marijuana both before and six months after the September 11 attacks. We provide an estimate of the proportion of the population who reported an increase in use of these substances six to nine months after September 11 in comparison to before the attacks. Two-tailed chi-square tests were used to detect associations between increase in substance use (increased cigarette

smoking, alcohol drinking, and marijuana use), current (i.e., within past month at time of interview) PTSD, and current depression. Prevalence of increased cigarette smoking, increased alcohol drinking, and increased marijuana use were cross-tabulated by each of the other covariates of interest. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for all bivariate associations. Variables that were associated with increased substance use ($p < 0.1$) in bivariate analyses were included in the final multivariable models allowing us to assess potential confounders and to examine interaction. Multiple logistic regression was used to examine associations separately for increase in cigarette smoking, alcohol drinking, and marijuana smoking. All calculated p-values were two-tailed and 95% confidence intervals were used to guide interpretation. We used SUDAAN for all analyses to correct standard errors and statistical tests for weighting (23).

RESULTS

Among 1570 New York City adults surveyed six months after September 11, 55.9% percent of the sample were women; mean age was 42 years [standard deviation (SD) = 15.4 years] and 35.8% were white, 28.7% were Hispanic, and 25.7% were African–American. The Manhattan south of One Hundred Tenth Street subsample of the six to nine month survey was 47.8% female, mean age was 43 years ($SD = 27$), 61.4% white, 18.6% Hispanic, and 9.9% African–American. Age, gender, race, and residence distributions in our sample (i.e., New York City, the boroughs, and Manhattan below One Hundred Tenth Street) were comparable to estimates obtained by the 2000 U.S. Census for our sampling frame (24).

Table 1 shows the prevalence of substance use for two one-month intervals (previous month when interviewed six to nine months after September 11 and one month before September 11) and the proportion who experienced any increase in substance use. Among all New Yorkers, 22.9% of participants reported smoking cigarettes, 34.1% drinking alcohol, and 4.8% using marijuana during the month prior to September 11. In the past month for the same sample, 24.8% reported smoking cigarettes, 39.3% drinking alcohol, and 5.2% smoking marijuana. Overall, increase in substance use was 9.9% for cigarettes, 17.3% for alcohol, and 2.7% for marijuana; overall, the proportion reporting an increase in any substance was 25.1%.

Among respondents who were cigarette smokers before September 11 (n = 320), 23 (7.2%) reported no recent smoking. The 9.9% overall increase in cigarette smoking included both new users (2.6%) and any increased frequency among those already using (7.3%). Among those who increased

Table 1. Use of substances before and six months after September 11 among a sample of New York City residents (n = 1570).

Substance	% used substance 30 days before September 11	95% confidence interval	% used substance past 30 days	95% confidence interval	% reporting an increase in use of substance since September 11*	95% confidence interval
Cigarettes	22.9	19.5–26.2	24.8	21.3–28.3	9.9	7.1–12.7
Alcohol	34.1	30.4–37.7	39.3	35.5–43.1	17.5	14.5–20.5
Marijuana	4.8	3.3–6.4	5.2	3.5–6.8	2.7	1.5–4.0

*Percent reporting any increase in use of substance comparing the month prior to the interview to the month before September 11, 2001.

smoking, 57.9% reported an increase of at least one pack per week (or 5.8% of the total sample). Of 639 respondents who reported alcohol use before September 11, 35 (5.5%) reported no use afterwards. The 17.5% increase in alcohol use included new users (7.3%) and any increase among former users (10.2%). Among those who increased alcohol use, 7.9% reported an increase of at least a drink per day. Among respondents who used marijuana before September 11 (n = 87), 9 (10.3%) reported no use six to nine months after September 11. Among the 2.7% who increased marijuana use were new users (0.9%) and an increase among former users (1.8%).

Table 2 shows the associations of substance increases with PTSD and depression. The overall prevalences of PTSD and depression for New York City six to nine months following September 11 were 1.5% and 6.0% respectively. Current PTSD (at 6–9 months) was more frequent in those who increased use than in those who did not for cigarettes (4.3% vs. 1.2%, p-value = 0.04). However, rates of PTSD were statistically similar for persons who increased alcohol use and those who did not (2.4% vs. 1.3%, $p = 0.34$), and for those who increased marijuana use vs. those who did not (4.0% vs. 1.4%, $p = 0.25$). Current depression was more frequent in those who increased use than those who did not for cigarette smoking (14.6% vs. 5.2%, $p = 0.01$), alcohol use (11.8. vs. 5.2%, $p = 0.02$), and for marijuana use (34.1% vs. 5.3%, $p < .001$). The rates of depression were higher among those who reported an increase in more than one substance compared to an increase in only one substance (data not shown).

Tables 3 shows bivariate associations between demographic and event exposure covariates and increases in cigarette smoking, alcohol use, and marijuana use. The covariates associated with an increase in cigarette smoking in bivariate analyses were: male gender ($p = 0.07$), having a high level of social support ($p = 0.01$), having a friend or relative killed ($p = 0.03$), and having lost a job as a result of the September 11 attacks ($p < 0.001$). The covariates associated with an increase in alcohol drinking in bivariate logistic regression models were: age ($p = 0.01$), gender ($p = .05$), race ($p = .03$), education ($p < .001$), marital status ($p = 0.03$), lifetime stressors ($p = 0.003$); life stressors since September 11 ($p = .01$), seeing the September 11 attacks in person ($p = 0.06$), peri-event panic attack ($p = 0.04$), and involvement in the rescue effort ($p = .02$). The covariates associated with an increase in marijuana smoking in bivariate analyses were: age ($p < 0.001$), race ($p = 0.001$), marital status ($p < 0.001$), life stressors in the 12 months before September 11 ($p = 0.08$), involvement in the rescue effort ($p = 0.05$), and having lost a job due to the September 11 attacks ($p = 0.06$). Persons who were directly affected by the attacks (defined as having been in the buildings or injured in the attacks, having a

Table 2. Association between substance use and PTSD and depression among New Yorkers, six months after September 11, 2001.

Substance	N	% PTSD past month	Chi-square	p-value	% depression past month	Chi-square	p-value
Total	1570	1.5			6.0		
Increase in cigarettes							
No	1400	1.2	4.3	0.04	5.2	6.2	0.01
Yes	128	4.3			14.6		
Increase in alcohol							
No	1225	1.3	0.9	0.34	5.2	5.5	0.02
Yes	271	2.4			11.8		
Increase in marijuana							
No	1495	1.4	1.3	0.25	5.3	15.6	0.0001
Yes	49	4.0			34.1		

Table 3. Bivariate associations between increase in substance use and demographics and event exposures among residents of New York City (n = 1570).

Characteristics	N	%	Increase in cigarette smoking since September 11			Increase in alcohol consumption since September 11			Increase in marijuana smoking since September 11		
			N	%	P-value	N	%	P-value	N	%	P-value
Total	1570	100.0									
Age											
18–24	157	14.7	21	13.7	0.14	31	25.3	0.01	11	8.2	< .00005
25–34	414	27.0	56	13.7		78	18.8		24	4.8	
35–44	329	19.6	18	9.3		72	20.0		5	0.1	
45–54	286	18.3	22	15.9		50	17.7		5	1.0	
55–64	175	11.2	6	4.0		23	9.6		2	0.3	
65+	190	9.2	5	3.9		14	5.6		2	0.3	
Gender											
Male	697	44.1	64	12.8	0.07	137	21.0	0.05	31	3.6	0.22
Female	873	55.9	64	7.6		134	14.8		18	2.0	
Race/ethnicity											
White	774	35.8	66	10.9	0.16	158	22.0	0.03	30	3.8	0.001
African American	264	23.7	23	11.4		39	15.1		8	3.4	
Asian	118	6.3	7	11.6		14	6.1		1	0.1	
Hispanic	332	28.7	29	9.1		46	15.3		6	1.1	
Other	53	5.5	1	0.9		11	25.5		3	1.9	
Income											
$100,000 +	233	10.7	18	7.7	0.27	50	15.7	0.10	11	7.3	0.56
$75,000–$99,999	119	10.3	7	5.1		27	16.0		4	3.5	
$50,000–$74,999	221	16.5	16	6.8		43	18.1		6	3.0	
$40,000–$49,999	110	7.3	11	8.3		28	8.3		4	3.6	
$30,000–$39,999	155	14.7	14	8.9		28	13.1		5	3.5	
$20,000–$29,999	161	16.9	22	17.3		24	11.4		7	3.0	
< $20,000	303	23.6	28	13.3		39	17.5		5	1.5	
Education											
Graduate degree	282	10.1	13	3.5	0.19	45	18.3	0.001	5	2.8	0.39
College degree	504	27.4	54	10.8		122	28.0		19	2.4	
Some college	273	22.0	23	12.9		42	12.0		14	4.7	
High school graduate/GED	295	24.7	26	9.7		43	16.1		9	2.7	
< High school graduate	207	15.9	12	9.1		19	9.7		2	0.9	
Marital status											
Married	541	43.4	35	9.5	0.16	77	15.7	0.01	8	0.8	< .00005
Divorced	165	8.2	9	4.3		26	10.7		4	1.6	
Separated	61	3.3	4	7.3		4	6.3		1	0.2	
Widowed	97	4.5	4	2.4		15	12.5		2	0.6	
Never married	633	37.6	69	12.6		133	21.6		32	6.1	
Unmarried couple	63	3.0	6	2.1		15	34.1		2	0.3	
Social support											
High	553	34.3	52	13.6	0.01	100	19.3	0.25	20	2.9	0.85
Medium	461	31.5	44	11.8		91	19.4		15	2.3	
Low	528	34.2	32	5.1		76	13.7		14	3.1	

(*continued*)

Table 3. Continued

Characteristics	N	%	Increase in cigarette smoking since September 11			Increase in alcohol consumption since September 11			Increase in marijuana smoking since September 11		
			N	%	P-value	N	%	P-value	N	%	P-value
Lifetime stressors before September 11											
0	467	31.3	23	6.5	0.02	60	14.0	0.003	8	2.2	0.96
1	371	23.2	23	8.3		62	19.0		11	2.8	
2–3	445	29.9	40	9.9		76	13.8		17	3.1	
4+	287	15.6	42	19.1		73	29.9		13	3.1	
Life stressors 12 months before September 11											
0	891	56.2	64	7.5	0.05	140	15.5	0.24	28	2.9	0.08
1	419	29.4	39	10.1		77	21.6		9	1.0	
2+	260	14.4	25	19.1		54	17.0		12	5.6	
Life stressors on/since September 11											
0			112	9.5	0.30	236	16.0	0.01	43	2.5	0.25
1+			16	13.6		35	29.9		6	5.0	
Live south of 14th St.											
No	901	96.3	71	10.0	0.48	156	17.6	0.83	23	2.7	0.19
Yes	669	3.7	57	8.6		115	17.1		26	4.2	
Saw September 11 attack in person											
No	925	73.8	73	10.9	0.28	140	15.8	0.06	22	2.2	0.32
Yes	633	26.2	55	7.6		130	22.2		26	3.6	
Fear of personal injury or death											
No	1111	73.1	74	8.5	0.25	191	17.6	0.86	32	2.6	0.65
Yes	387	26.9	46	11.8		71	18.2		15	3.3	
Panic attack											
No	1292	81.7	99	9.2	0.25	206	16.1	0.04	37	2.3	0.23
Yes	278	18.3	29	13.3		65	24.2		12	4.5	
Friend or relative killed											
No	1354	85.0	101	8.4	0.03	229	16.9	0.31	44	3.0	0.31
Yes	216	15.0	27	18.0		42	21.1		5	1.5	
Lost possessions											
No	1481	96.5	120	9.5	0.18	251	17.3	0.38	46	2.6	0.43
Yes	88	3.5	8	20.2		20	23.9		3	5.7	
Involved in rescue effort											
No	1380	89.9	105	9.7	0.55	224	16.4	0.02	39	2.2	0.05
Yes	189	10.1	23	12.0		47	28.1		10	7.2	
Lost job due to the September 11 attacks											
No	1457	93.4	112	8.5	0.0005	25	32.5	0.02	43	2.4	0.06
Yes	103	6.6	15	29.1		246	16.6		6	8.0	
Directly affected*											
No	1098	71.6	77	7.9	0.03	168	15.4	0.02	29	1.9	0.05
Yes	472	28.3	51	14.9		103	23.1		20	4.8	

*Includes friend or relative killed, possessions lost or damaged, lost job, involved in rescue effort.

Table 4. Multivariate models of predictors of increased substance use among New Yorkers (n = 1570) six months after September 11, 2001.

	Increase in cigarette smoking			Increase in alcohol consumption			Increase in marijuana Smoking		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Age									
18–24				1.0	–	–	1.0	–	–
25–34				0.5	0.2–0.9	0.03	0.5	0.2–1.3	0.15
35–44				0.5	0.2–1.1	0.09	0.01	0.0–0.1	< 0.0001
45–54				0.5	0.2–1.3	0.14	0.1	0.02–0.7	0.02
55–64				0.2	0.1–0.5	0.0006	0.03	0.01–0.1	< 0.0001
65+				0.1	0.02–0.4	0.002	0.02	0.0–0.4	0.009
Gender									
Male	1.0	–	–	1.0	–	–			
Female	0.6	0.3–1.1	0.07	0.6	0.3–1.0	0.03			
Race/Ethnicity									
White				1.0	–	–	1.0	–	–
African American				0.9	0.5–1.8	0.85	0.6	0.2–2.2	0.44
Asian				0.2	0.1–0.8	0.02	0.01	0.0–0.01	0.0003
Hispanic				0.9	0.5–1.8	0.81	0.2	0.03–0.8	0.03
Other				0.8	0.3–2.4	0.73	0.4	0.1–2.4	0.32
Income									
$100,000 +				1.0	–	–			
$75,000–$99,999				1.2	0.5–2.9	0.72			
$50,000–$74,999				0.7	0.3–1.8	0.48			
$40,000–$49,999				0.7	0.2–1.9	0.44			
$30,000–$39,999				0.6	0.2–1.6	0.33			
$20,000–$29,999				0.6	0.2–1.8	0.37			
< $20,000				0.6	0.2–1.6	0.30			
Education									
Graduate degree				1.0	–	–			
College degree				1.6	0.8–3.3	0.18			
Some college				0.5	0.2–1.3	0.15			
High school graduate/GED				0.7	0.3–1.6	0.33			
< High school graduate				0.8	0.3–2.5	0.74			
Marital status									
Married				1.0	–	–	1.0	–	–
Divorced				0.7	0.3–1.8	0.47	3.0	0.7–14.1	0.16
Separated				0.2	0.04–1.0	0.05	0.4	0.03–4.1	0.42
Widowed				5.6	1.5–21.5	0.01	3.1	0.2–45.2	0.41
Never married				1.3	0.7–2.3	0.42	3.1	1.0–10.0	0.06
Unmarried couple				2.5	1.0–6.6	0.06	0.2	0.03–1.8	0.16
Social support									
High	1.0	–	–						
Medium	0.7	0.3–1.4	0.28						
Low	0.3	0.1–0.6	0.002						
Lifetime stressors before September 11									
0	1.0	–	–	1.0	–	–			
1	1.0	0.4–2.5	0.95	1.4	0.7–2.9	0.30			
2–3	1.0	0.4–2.3	0.99	0.9	0.5–1.8	0.75			
4+	2.0	0.8–5.0	0.11	2.5	1.3–5.0	0.009			

(*continued*)

Table 4. Continued.

	Increase in cigarette smoking			Increase in alcohol consumption			Increase in marijuana smoking		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Life stressors 12 months before September 11									
0	1.0	–	–				1.0	–	–
1	1.2	0.6–2.3	0.68				0.3	0.1–1.6	0.16
2+	2.3	1.0–5.3	0.06				2.7	0.8–9.0	0.11
Life stressors on/since September 11									
0				1.0	–	–			
1+				1.2	0.6–2.1	0.66			
Saw September 11 attacks in person									
No				1.0	–	–			
Yes				1.1	0.7–1.8	0.74			
Panic attack									
No				1.0	–	–			
Yes				1.9	1.1–3.3	0.03			
Friend or relative killed									
No	1.0	–	–						
Yes	1.6	0.8–3.3	0.19						
Involved in rescue effort									
No				1.0	–	–	1.0	–	–
Yes				1.5	0.7–3.0	0.28	5.1	1.3–20.6	0.02
Lost job due to September 11 attacks									
No	1.0	–	–	1.0	–	–	1.0	–	–
Yes	3.9	1.8–8.5	0.0005	1.4	0.6–3.4	0.47	2.1	0.4–11.0	0.37

friend or relative killed, possessions lost or damaged, lost job as a result of the attacks, or involved in rescue effort) were more likely than those not directly affected to report an increase in use of cigarettes ($p = .03$), alcohol ($p = .02$) and marijuana use ($p = .05$).

Table 4 shows final multivariable models predicting increases in each substance at six to nine months after September 11. The adjusted covariates associated (i.e., $p < 0.10$) with an increase in cigarette smoking were being male ($p = 0.07$), high social support ($p = 0.002$), at least two life stressors in the year before September 11 ($p = .06$), and having lost a job due to the September 11 attacks ($p < 0.001$). For the model of increase in alcohol use, the most important covariates were age between 25–34 years, 55–64, and ≥ 65 (OR = 0.5, $p = 0.03$; OR = 0.2, $p = 0.0006$; OR = 0.1, $p = 0.002$ respectively, compared to referent 18–24 years), male gender ($p = 0.03$), being separated, widowed, or an unmarried couple ($p = 0.05$, 0.01, 0.06 respectively compared to referent married), having four or more lifetime stressors before September 11 ($p = 0.009$ compared to no stressors referent), and having had a peri-event panic attack ($p = 0.03$). The adjusted covariates associated with an increase in marijuana were: age 35–44 years, 45–54, 44–64, ≥ 65 (OR = 0.01, $p < 0.0001$; OR = 0.1, $p = 0.02$; OR = 0.03, $p < 0.0001$; OR = 0.02, $p = 0.009$ respectively, compared to referent: 18–24 years), Asian or Hispanic ethnicity (OR = 0.01, $p = 0.0003$; OR = 0.2; $p = 0.03$ respectively, compared to referent whites), never married ($p = 0.06$ compared to referent married), involved in the rescue effort ($p = .02$).

To examine trends in substance use at two time points, we restricted the NYC sample at six to nine months after September 11 and to Manhattan below One Hundred Tenth Street, to correspond to the sample frame from the survey conducted one to two months after September 11. In the first survey (n = 988), the prevalence of cigarette, alcohol, and marijuana use before September 11 was 22.6%, 59.1%, and 4.4%, respectively, while five to eight weeks after September 11, prevalences were 23.4%, 64.4% and 5.7%, respectively. The proportion who reported an increased frequency of substance use was 28.8% overall, and 9.7%, 24.6%, and 3.2% for cigarettes, alcohol, and marijuana, respectively. One to two months after September 11 the prevalence of PTSD and depression were 7.5% and 9.7%, respectively. For the survey conducted at six to nine months after September 11, in the Manhattan below One Hundred Tenth Street subset (n = 854) the proportion who increased frequency of substance use was 8.3%, 19.0%, and 5.1%, respectively. The prevalence of cigarette, alcohol, and marijuana use before September 11 was 25.1%, 59.1% and 7.5%, respectively, whereas at six to nine months afterwards, it was 24.8%, 59.6%, and 7.7%, respectively. The prevalence of PTSD and depression in the most recent

month were 0.6% and 5.3%, respectively (6). Thus, while rates of psychopathology have shown substantial resolution since September 11, the proportion reporting they have increased their substance use above pre-September 11 levels remained relatively stable.

DISCUSSION

Substance use has been previously described as a significant problem after disasters and after traumatic events (10–13). For example, using comparable methodology to our study, a national survey of women found that 38.7% of women with a history of assault smoked compared to 23.6% of women with no history of assault (9). However, different time frames for assessment, different measures of substance use, and a predominant focus on direct survivors, make it difficult to compare the observed substance use increases in our study to these previous studies. Although a few studies have shown that degree of event exposure is associated with a greater degree of substance use after disasters (25,26), different measures of disaster exposure make it difficult to draw conclusions about changes in substance use and different degrees of traumatic event exposure. Studies of uniformed personnel who have significant exposure to disasters and traumatic events show higher rates of problems with alcohol use than in the general population (27). In this analysis, persons who were directly affected, especially with job loss due to the September 11 attacks, were more likely to increase their cigarette smoking when controlling for other covariates. With alcohol and marijuana use, being part of the rescue effort was associated with increased consumption six to nine months after the events. However, other event exposure measures including seeing the event, being displaced from home, or losing possessions during the attacks were not consistently associated with increased substance use.

Epidemiological evidence suggests that men are more likely to have lifetime-diagnoses of substance use dependence than women (28). However, there is little convincing evidence that changes in substance use after disasters are different between men and women (29). We did note that men were more likely to report increases in cigarettes and alcohol but no gender difference was noted for marijuana use. Similarly, although data suggest that race/ethnicity may be related to the likelihood of posttrauma psychopathology (30), there is little evidence for different rates of substance use increase by racial/ethnic groups postdisaster. In our analyses Asians were least likely to report increases in alcohol and marijuana use.

We documented an association between increases in cigarette consumption and current PTSD and an association between cigarette,

alcohol, and marijuana consumption and depression. The estimates of increased substance use among persons with PTSD and depression in our sample are consistent with the documented co-morbidity of substance use and PTSD in other samples. For example, among survivors of the Oklahoma City bombing, 32.4% of subjects with PTSD drank alcohol (31).

A number of hypotheses may account for increased substance use after disasters. First, persons who experience major trauma may use substances to relax and cope with stress and negative affect. This has been documented in the context of laboratory studies of smokers (32). Second, persons with anxiety disorders (e.g., PTSD) may suffer exacerbated withdrawal symptoms, particularly irritability or nervousness (33). Third, persons with PTSD or depression might use drugs in an attempt to self-medicate symptoms (34). Fourth, once psychopathology has developed, substance use could exacerbate symptomatology, interfering with the resolution of the traumatic experience and prolonging symptoms following the disaster.

Our surveys measured PTSD, depression, and substance use concurrently, thus temporality in the associations cannot be established. However, the trends of resolution for PTSD and depression and the elevated levels of substance use six to nine months after September 11 that were similar to elevations of use one to two months after September 11 suggest that the relationship of psychological symptoms and substance use is complex. The possibility that persons who initially sought to self medicate or cope with stress have maintained higher levels of use despite a trend toward symptom resolution suggests addictive potential of substances may have lingering effects well beyond the event exposure and the psychological response to the event itself. These data do not measure abuse or dependence, but increased use of substances has other well known health implications that public health officials will need to address. In our earlier report, peri-event panic attack was consistently associated with an increase in use of all substances in bivariate analyses and with an increase in marijuana and cigarette smoking in adjusted models in our earlier work at five to eight weeks after the disaster. However, at six to nine months after September 11, peri-event panic attack was associated only with alcohol use. These data suggest that the psychological risk factors for substance use may vary over time and that some factors that are significant early may be replaced by other factors at later time periods.

The observations we draw from this study must be interpreted with caution. At the time of the study residents of New York City were on heightened alert with ongoing concern about possible further terrorist attacks. In addition, the concomitant evolving economic recession added to stressors faced by New York City at the time. This may mean that a degree of the observed substance use increase was associated with other stressors

in addition to the events of September 11 themselves. Rates of substance use increase in more circumscribed disasters may be expected to be lower than those observed in this study. We collected data using anonymous telephone interviews, raising the possibility of under-reporting of substances used. It also is possible that respondents' recall may have been less accurate when asked about substance use before September 11 than it was when asked about substance use in the period prior to the survey. Baseline prevalence of smoking, alcohol drinking, and marijuana use however are comparable to national estimates (35) providing some basis for confidence in the self-reported measures. We note that the population of Manhattan below One Hundred Tenth Street over time is largely white, affluent, and well-educated. It is difficult to generalize these results to more sociodemographically diverse groups.

The substantial increase in substance use that we documented soon after the September 11 attacks, together with its co-occurrence with mental health problems, suggests that public health practitioners in the post-disaster period may consider raising awareness of these issues among the general public, and among clinicians, in the early post-disaster period. Future research should explore the relations between event-exposure, psychopathology, and substance use and dependence.

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