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Abbreviations: aOR, adjusted odds ratio; DPS, DISC (Diagnostic Interview Schedule for Children) Predictive Scales; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; NYC, New York City; PCL, PTSD checklist; PTSD, posttraumatic stress disorder; SDQ, Strengths and Difficulties Questionnaire; WTC, World Trade Center

Behavioral problems and psychopathologies were reported in children exposed to the World Trade Center (WTC) attacks in New York City within 2–3 y post-disaster. Little is known of subsequent 9/11 related behavioral and emotional problems. We assessed risk factors for behavioral difficulties and probable posttraumatic stress disorder (PTSD) in 489 adolescent enrollees ages 11–18 y of age in the World Trade Center Health Registry cohort using the Strengths and Difficulties Questionnaire (SDQ) and DISC Predictive Scales (DPS), respectively, as reported by the adolescents. Associations between parental PTSD and adolescent PTSD and behavioral problems were studied in a subset of 166 adolescent-parent pairs in which the parent was also a Registry enrollee. Nearly one-fifth (17.4%) of the adolescents, all of whom were 5–12 y old at the time of the attacks, scored in the abnormal (5.7%) or borderline (11.7%) range of total SDQ. Problems were more frequent in minority, low-income, and single-parent adolescents. Abnormal and borderline SDQ scores were significantly associated with direct WTC exposures and with WTC-related injury or death of a family member. Adolescent PTSD was significantly associated with WTC exposure and with fear of one's own injury or death, and with PTSD in the parent (OR = 5.6; 95% CI 1.1–28.4). This adolescent population should be monitored for persistence or worsening of these problems. Co-occurrence of parent and child mental health symptoms following a disaster may have implications for healthcare practitioners and for disaster response planners.

Introduction

Posttraumatic stress disorder (PTSD), depression, and other mental health consequences have been extensively documented in adults following the terrorist attacks on the World Trade Center in New York City (NYC) on September 11, 2001[1] and in specific adult groups that directly experienced traumatic exposures such as firefighters, police, and other rescue/recovery workers,[2-9] residents and workers employed in Lower Manhattan,[10,11] and evacuees from the 2 World Trade Center towers.[12] A more limited literature that has focused on the estimated 25,000 children who were also directly exposed to the disaster suggests a wide range of serious 9/11 related mental health and behavioral outcomes affecting children and adolescents.[13-20] Many families experienced traumatic exposures including evacuation, destruction of or severe damage to living quarters, loss of parental employment or other financial hardship, and abrupt changes in the child's social network.[21] Consequently, the constellation of exposures experienced by children often included a family environment in which one or both parents suffered 9/11-related physical or mental health outcomes which may have in turn affected children's own mental health and behavior. Effects on child behavior of parental stress due to 9/11 have been reported in a number of studies, some of which included very young children;[20-24] however, most pediatric studies were based on data gathered shortly after 9/11, and do not reflect more recent health or behavioral status. We report here behavioral outcomes ascertained 6–7 y after 9/11 in 489 adolescents ages 11–18 y (i.e., 5–12 y old at the time of the WTC attack), and relate these outcomes to 9/11 exposures and family environment. We also report the relationship between probable PTSD in parents and behavior problems and PTSD in a subset of 166 adolescents whose parents are also Registry enrollees.

Methods

World Trade Center Health Registry ("Registry")

The Registry longitudinally follows a cohort of 71,434 individuals, including rescue and recovery workers, lower Manhattan residents living south of Canal Street, students and staff at schools south of Canal Street, building occupants, and passersby south of Chambers Street on 9/11; details have been presented elsewhere.[3,11] Briefly, enrollees were recruited from lists of potentially exposed persons obtained from employers and government agencies (30%), and through outreach and media campaigns (70%). Eligible persons were enrolled and interviewed in 2003–04 (Wave 1) via computer-assisted telephone interview (95%) or in person (5%). Children <18 y of age were recruited through their parents and active outreach to community organizations and schools. Numerous schools south of Canal Street in Manhattan, including child care centers, nursery schools, and public and private schools with grades kindergarten through 12th (K–12) were contacted by mail and telephone. Registry staff also gave presentations about the project to teacher and parent groups. In particular, the New York City Department of Education and several private schools endorsed the Registry project to families with potentially exposed children. Children's eligibility for the Registry was determined by residence, enrollment in a school located south of Canal Street, being present south of Chambers Street in Manhattan on the morning of 9/11, or volunteering for 9/11-related rescue or recovery work. Further recruitment details have been provided by Dolan et al.[25]

The Wave 1 (enrollment) questionnaire gathered data on demographics, medical history, a wide variety of 9/11 experiences and exposures, and current health, and was identical for adults and children, except for sections on mental health. Parents or guardians completed questionnaires for enrollees under age 18 y. Follow-up surveys (Wave 2) were conducted in 2006–07 for adults, and 2007–08 for adolescents aged 11–17 y as of 4/1/2007 to update health information and gather additional exposure data. Adult follow-up surveys were completed by mailed questionnaire (44%), online (44%), or by telephone interview (12%), while adolescent surveys were completed by mailed questionnaire only. Because eligibility criteria applied to individuals and not families, not all parents of child enrollees were themselves eligible for enrollment and we do not have baseline data for parents who are not enrollees. Therefore, at Wave 2 parents of adolescents completed an "adult" questionnaire that provided data on their relationship to the adolescent, household composition and income, the parent's own emotional health, and the adolescent's 9/11 exposures and physical health. Adolescents completed a separate questionnaire about their behavior and mental health, for which a separate return envelope was provided for confidentiality.[26] A total of 506 sets of questionnaires were received from these parent-adolescent pairs; 489 pairs had complete data on adolescent behavior and PTSD and form the population for the main analysis. Within these 489 pairs there were 166 in which the parent was also an enrollee for whom complete PTSD data were available. These "enrollee dyads" were used to
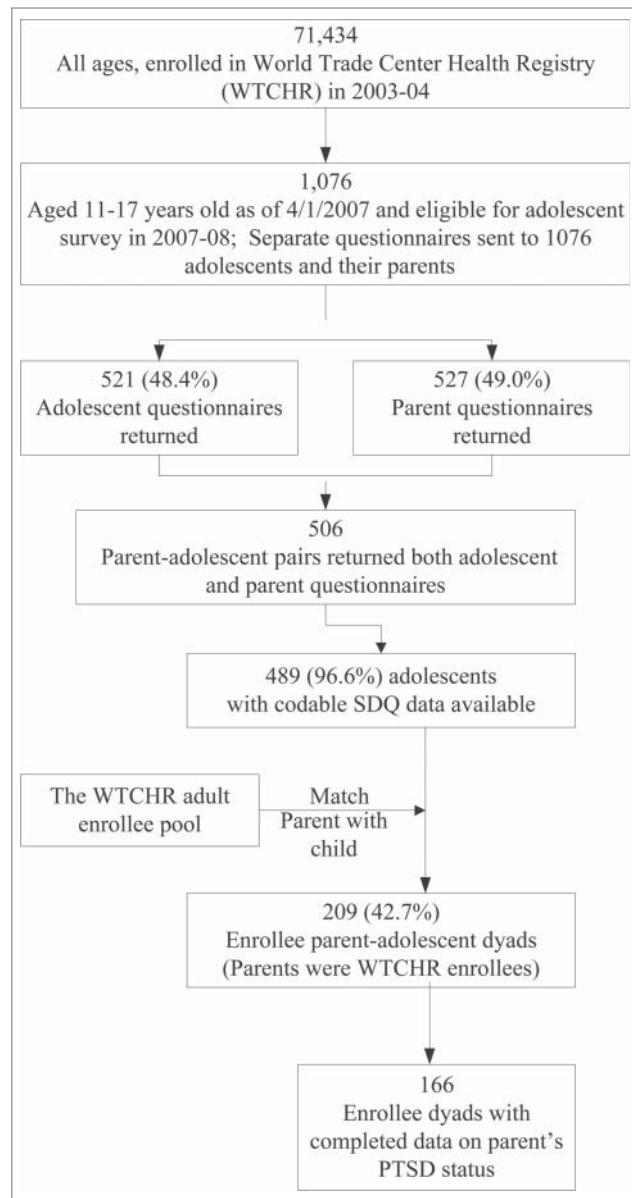
Figure 1. Study sample selection.

relate parental and adolescent PTSD. **Figure 1** illustrates the composition of the 2 study pools.

The Institutional Review Boards of the NYC Department of Health and Mental Hygiene and the Centers for Disease Control and Prevention approved this study.

PTSD measures: parent

Probable PTSD among enrollee parents was assessed at Waves 1 and 2 using a 9/11 stressor-specific PTSD checklist (PCL) in combination with DSM-IV criteria.[27] The PCL is a 17 item self-report instrument on which respondents rate scale items referring to psychological symptoms occurring during the previous 30 days; 8 of the 17 items were worded to refer specifically to the WTC disaster. The 17 PCL items are scored on a 5-point scale

and totaled. A cutoff score of 44 or above, and endorsement of at least one re-experiencing symptom (DSM-IV criterion B), 3 avoidance symptoms (DSM-IV criterion C), and 2 hyperarousal symptoms (DSM-IV criterion D) was considered indicative of probable PTSD.[28] Use of the PCL has been validated in numerous studies of civilian populations exposed to assault, motor vehicle trauma, major illnesses, and terrorism, including the 9/11 attacks[28-31] and it has demonstrated strong psychometric properties (sensitivity=0.94–0.97, specificity=0.86–0.99) in other populations using a cutoff of 44.[29,32,33]

PTSD measures: adolescents

Probable PTSD among adolescents was assessed using the Diagnostic Interview Schedule for Children (DISC) Predictive Scales (DPS). The DPS has previously been used to assess the prevalence of probable mental disorders among New York City public school students 6 months following the World Trade Center attack.[16] This scale was modified from a structured diagnostic interview, the National Institute of Mental Health's DISC Version IV, incorporating the DISC items most predictive of the DSM-IV PTSD diagnosis, and has demonstrated a sensitivity of 85% and a specificity of 98%.[16] The adolescent PTSD scale from the DPS is composed of 8 questions about presence or absence of 9/11-related symptoms of stress (e.g., re-experiencing, avoidance, or sense of a foreshortened future) and 7 questions about stress-related functioning (e.g., problems with schoolwork or parental concern about adolescent behavior) during the 4 weeks prior to interview. Stress-related functioning questions are scored as 0, 0, 1, and 2 for responses of "not at all," "hardly ever," "some of the time," and "a lot of the time," respectively. Adolescents who endorsed 5 or more symptoms, and scored 3 or higher on the functioning scale were categorized as having "probable PTSD" to reflect the fact that the pediatric DPS and adult PCL scales are screening and not diagnostic tools.[34]

Behavioral assessment

Behavioral difficulties among adolescents were assessed at Wave 2 (2007–08) using the adolescent-reported Strengths and Difficulties Questionnaire (SDQ). The SDQ is a reliable screening instrument for child and adolescent behavioral problems that asks about 25 positive and negative behaviors, scored as 0, 1, and 2 for responses of "not true," "somewhat true," and "certainly true," respectively.[35-38] Higher borderline and abnormal SDQ scores have been correlated with other existing questionnaire and interview measures, and have been shown to be related to increasing rates of clinician-rated diagnoses of child mental disorder.[35,39]

The 25 SDQ items are divided into 5 domains, providing domain scores for conduct problems, hyperactivity, emotional symptoms, peer problems, and prosocial behavior, as well as a total (difficulties) score, which sums items on the 4 problem subscales (all domains except prosocial behavior), and ranges from 0–40. In our analysis, total scores were categorized as normal (0–15), borderline (16–19), or abnormal (20–40) as in previous studies of mental health assessments of children.[40] Abnormal and borderline individual domain scores were combined into a single

outcome due to small numbers as follows: peer and conduct problem domain scores were dichotomized as normal (0–3) and borderline/abnormal (4–10), while emotional problem and hyperactivity domain scores of 0–5 were categorized as normal, and scores of 6–10 as borderline/abnormal.

Adolescent 9/11 exposure

Adolescent 9/11-related exposures were assessed using information from the adolescent's Wave 1 questionnaire as reported by a parent proxy, the Wave 2 parent questionnaire, and the Wave 2 adolescent questionnaire. Exposures included presence in Manhattan south of Chambers Street on 9/11 morning, direct exposure, and family WTC exposure. Direct exposure was defined as having experienced 2 or more of the following on 9/11: (1) witnessed one or more disturbing events during and after the WTC attacks (airplane crashing into a tower, buildings collapsing, people running away from a cloud of smoke, or people being injured, killed, falling, or jumping from one of the towers), (2) sustained an injury as a result of the attacks (burn, broken bone, concussion, cut, sprain, or other injury), (3) was caught in the dust cloud that resulted from the collapse of the WTC towers, (4) evacuated from school, and (5) thought loved one might be injured or killed on 9/11. Family exposure was defined as having a family member (mother, father, sibling, grandparent or any other family member) who was injured or killed in the attacks, or was in the WTC disaster and escaped unhurt. Adolescent-reported fear for personal safety on 9/11 was also assessed in addition to direct and family exposures.

Statistical analyses

Bivariate associations between SDQ score categories and demographic indicators were assessed using Pearson's chi-squared test. For cells with ≤5 observations Fisher's exact test was used. The Cochran-Armitage trend test was used to test for trends in proportions. Multivariate logistic regression was used to estimate associations between 9/11 exposures and categories of SDQ score, adjusting for demographic variables that were significantly associated with SDQ score in bivariate analyses. Associations between parental PTSD and each of the 4 SDQ subscales, and between parental and adolescent PTSD were also estimated using logistic regression models comparing individuals scoring in the abnormal or borderline range with those scoring in the normal range. The multivariate analyses included adjustments for variables that were associated with SDQ in bivariate analyses or in previous studies, and included demographic variables, number of adults in household, and presence of a smoker at home. All analyses were performed using SAS software version 9.2 (SAS Institute, Inc., Cary, NC), and tests were 2-sided with a significance level of $P < 0.05$.

Results

Demographics and SDQ status

Demographic characteristics, household information, indicators of health care access, and adolescents' SDQ status are

Table 1. Demographic Characteristics of Adolescents Aged 11–19 y by Self-completed Strengths and Difficulties Questionnaire (SDQ) Total Score at Wave 2

	Total[a]		Abnormal (SDQ: 20–40)		Borderline (16–19)		Normal (0–15)		
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	*P*-value for trend[b]
Total No.	489		28		57		404		
Age at Wave 2 (age on 9/11)									
11–15 y (5–9 years)	316	(64.6)	20	(71.4)	30	(52.6)	266	(65.8)	n.s.
16–19 y (>9 to 12 years)	173	(35.4)	8	(28.6)	27	(47.4)	138	(34.2)	
Gender									
Male	223	(45.6)	11	(39.3)	20	(35.1)	192	(47.5)	n.s.
Female	266	(54.4)	17	(60.7)	37	(64.9)	212	(52.5)	
Race/ethnicity									
Non-Hispanic White	254	(51.9)	7	(25.0)	18	(31.6)	229	(56.7)	<0.0001[c]
Non-Hispanic Black	33	(6.7)	2	(7.1)	6	(10.5)	25	(6.2)	
Hispanic	72	(14.7)	9	(32.1)	18	(31.6)	45	(11.1)	
Asian	100	(20.4)	7	(25.0)	13	(22.8)	80	(19.8)	
Multiracial or Other	30	(6.1)	3	(10.7)	2	(3.5)	25	(6.2)	
Household gross income in 2005, $									
≥75,000	238	(51.7)	7	(26.9)	17	(33.3)	214	(55.9)	0.0001
<75,000	222	(48.3)	19	(73.1)	34	(66.7)	169	(44.1)	
Parental education, Wave 2									
Post-graduate degree	179	(36.6)	7	(25.0)	16	(28.1)	156	(38.6)	< 0.01
Some or completed college	203	(41.5)	13	(46.4)	19	(33.3)	171	(42.3)	< 0.05
High school graduate or under	107	(21.9)	8	(28.6)	22	(38.6)	77	(19.1)	
Number of adults in household, Wave 2									
One	91	(18.9)	13	(46.4)	15	(27.3)	63	(15.8)	<0.0001
Two or more	390	(81.1)	15	(53.6)	40	(72.7)	335	(84.2)	
Smoker in the home, Wave 2									
No	423	(87.0)	18	(66.7)	46	(80.7)	359	(89.3)	0.0002
Yes	63	(13.0)	9	(33.3)	11	(19.3)	43	(10.7)	
Child's unmet health care needs in the last 12 months									
No	452	(94.8)	23	(82.1)	51	(89.5)	378	(96.4)	0.0001
Yes	25	(5.2)	5	(17.9)	6	(10.5)	14	(3.6)	
Talked to professional about the child's mental or emotional problems in the last 12 months									
No	331	(69.5)	6	(21.4)	28	(50.9)	297	(75.6)	<0.0001
Yes	145	(30.5)	22	(78.6)	27	(49.1)	96	(24.4)	

n.s., not significant
[a]Numbers may not add up to 489 due to missing data; % was computed based on available data.
[b]Cochran-Armitage trend test for 3 categories of SDQ, except race/ethnicity.
[c]Fisher's exact test for overall.

presented in **Table 1**. Due to delay in receiving and replying to the Wave 2 questionnaire, a few adolescents were 19 y old by the time they completed the survey; adolescents' age at Wave 2 ranged from 11 to 19 years, with about twice as many younger adolescents (11–15 years) as older (16–19 years), and a slight preponderance (54.4%) of girls. The study population was 52% white, 20% Asian, 15% Hispanic, and 7 % black. Approximately half (51.7%) the sample reported a household income of $75,000 or more in 2005, and about one-fifth of adolescents (18.9%) lived in a one-parent household. Only 5.2% of parents reported an unmet health care need for the child, while over one-fourth (30.5%) of parents reported talking to a professional about the child's mental or emotional problems during the preceding year.

Total SDQ scores among the 489 adolescents in the study ranged from 0 to 30, with a mean of 9.5 and a median of 8.0. Four hundred and 4 adolescents (82.6%) had normal SDQ total scores, 57 (11.7%) had borderline total SDQ scores, and 28 (5.7%) had abnormal total SDQ scores. The total SDQ score was not associated with age or gender. Both borderline and abnormal total SDQ scores were associated with Hispanic ethnicity, lower household income (<$75,000/year), lower education, living in a single-parent household, presence of a smoker in the home, and having unmet health care needs (*P*-value for trend <0.01). Over three-fourths (78.6%) of adolescents with an abnormal total SDQ score, and nearly half (49.1%) of those with a borderline score had a parent who reported seeking professional help for their

Table 2. WTC Disaster Related Exposures and their Associations with Adolescent Total SDQ Score (N = 489)

Model #	WTC exposures	Total No.	Total (%)	Abnormal (SDQ: 20–40) No.	Abnormal (%)	Borderline (16–19) No	Borderline (%)	Normal (0–15) No.	Normal (%)	Adjusted OR (95% CI)[a] Abnormal	Adjusted OR (95% CI)[a] Borderline
	Total No.	489		28		57		404			
1	Presence south of Chambers Street on 9/11 morning										
	No	224	(45.8)	12	(32.9)	21	(36.8)	191	(47.3)	referent	referent
	Yes	265	(54.2)	16	(57.1)	36	(63.2)	213	(52.7)	1.2 (0.5–2.7)	1.5 (0.8–2.9)
2	Direct WTC exposure										
	0–1 exposure	151	(30.9)	3	(10.7)	11	(19.3)	137	(33.9)	referent	referent
	2–5	338	(69.1)	25	(89.3)	46	(80.7)	267	(66.1)	4.2 (1.2–14.8)	2.3 (1.1–4.9)
3	Any family member exposed to WTC attacks (family exposures)										
	No	373	(76.3)	18	(64.3)	48	(84.2)	307	(76.0)	referent	referent
	Yes	116	(23.7)	10	(35.7)	9	(15.8)	97	(24.0)	1.9 (0.8–4.5)	0.5 (0.2–1.2)
4	Any family member injured or killed in the WTC disaster[b]										
	No	462	(94.5)	22	(78.6)	54	(94.7)	386	(95.5)	referent	referent
	Yes	27	(5.5)	6	(21.4)	3	(5.3)	18	(4.5)	5.1 (1.6–16.6)	1.2 (0.3–4.4)
5	Thought self might be injured or killed (fear for self safety)										
	No	341	(69.7)	14	(50.0)	31	(54.4)	296	(73.3)	referent	referent
	Yes	148	(30.3)	14	(50.0)	26	(45.6)	108	(26.7)	2.5 (1.1–5.7)	2.3 (1.2–4.2)

OR, odds ratio; CI, confidence interval.
[a]Each model contains only the indicated WTC exposure variable along with the adjustment variables: adolescents' demographics, number of adults in household, and smoker at home.
[b]One of family exposure components.

child in the preceding year, compared to 24.4% of adolescents with scores in the normal range ($P < 0.0001$).

Adolescent SDQ and WTC exposure

The adjusted odds ratios for associations between WTC exposures and both abnormal and borderline total SDQ scores are shown in **Table 2**. The adjusted odds ratio for the association between direct exposure and abnormal total SDQ scores was 4.2 (95% CI: 1.2–14.8); for borderline SDQ scores it was 2.3 (95% CI: 1.1–4.9). Although the family WTC exposure index was not associated with abnormal or borderline SDQ scores, having a family member injured or killed in the WTC disaster was strongly associated with abnormal SDQ scores (aOR: 5.1; 95% CI: 1.6–16.6). Adolescent-reported fear for personal safety was also highly associated with abnormal (aOR: 2.5; 95% CI 1.1–5.7) and borderline (aOR: 2.3; 95% CI: 1.2–4.2) SDQ scores.

Adolescent PTSD and WTC exposure

There were 26 (5.4%) adolescents with symptoms and impairment indicative of PTSD, of whom 24 (92.3%) reported ≥2 direct WTC exposures, and 9 (34.6%) reported having feared for their personal safety on 9/11. As shown in **Table 3**, both direct WTC exposure and fear for personal safety on 9/11 were highly associated with PTSD (aOR: 6.6, 95% CI: 1.5–29.8 , and aOR: 4.4, 95% CI: 1.8–10.7, respectively).

Adolescent SDQ and PTSD in relation to parental PTSD

There were 166 "enrollee dyads" within which parental PTSD status had been ascertained. **Table 4** shows adjusted odds ratios for associations of parental probable PTSD with total SDQ score, scores on each of the 2 internalizing SDQ sub-scales (peer

problems and emotional symptoms), and scores on each of the 2 externalizing SDQ sub-scales (conduct problems and hyperactivity) among the 166 "enrollee dyads." Of the 35 parents with probable PTSD, 7 had it at both waves, 8 had resolved by Wave 2, 12 were first reported at Wave 2, and 8 had missing data at one of the waves. Parental PTSD was significantly associated with adolescent borderline/abnormal scores on the total SDQ (aOR: 3.2; 95% CI: 1.1–8.8), and on each of the 2 internalizing sub-scales (peer problems aOR: 23.5; 95% CI: 5.9–93.2; emotional symptoms aOR: 3.6; 95% CI: 1.2–11.0). Neither of the externalizing sub-scales was associated with parental PTSD.

Adolescent PTSD and parental PTSD

Of the 166 "enrollee dyads," 164 adolescents had complete data on the DPS. One male and 7 female adolescents had DPS scores indicative of probable PTSD. Five of the 8 parents linked to these adolescents in the Registry were assessed as having probable PTSD at either Wave 1 or Wave 2 (3 in both Waves). Adolescent probable PTSD was significantly associated with parental probable PTSD, as shown in **Table 5** (aOR: 5.6; 95% CI: 1.1–28.4).

Discussion

Six to 7 y after the World Trade Center attacks we observed behavioral and emotional difficulties in nearly one-fifth (17.4%) of adolescents with direct and substantial exposures and who were 5–12 y old at the time of the attacks. This figure is higher than US population rates among adolescents ages 11–17 y (9.2%) which are based on parent reporting,[36] while data in our study were obtained from the adolescents themselves. However,

Table 3. WTC Disaster Related Exposures and their Associations with Adolescent PTSD (N = 482)[a]

Model #	WTC exposures	PTSD No.	PTSD (%)	Adjusted OR (95% CI)[b]
	Total No.	26	5.4	
1	Presence south of Chambers Street on 9/11 morning			
	No	7	(26.9)	referent
	Yes	19	(73.1)	2.3 (0.9–5.8)
2	Direct WTC exposure			
	0–1 exposure	2	(7.7)	referent
	2–5	24	(92.3)	6.6 (1.5–29.8)
3	Any family exposed to WTC attacks (family exposures)			
	No	18	(69.2)	referent
	Yes	8	(30.8)	1.5 (0.6–3.7)
4	Any family member injured or killed as a result of the WTC disaster[c]			
	No	21	(80.8)	referent
	Yes	5	(19.2)	3.2 (0.98–10.1)
5	Thought self might be injured or killed			
	No	17	(65.4)	referent
	Yes	9	(34.6)	4.4 (1.8–10.7)

OR, odds ratio; CI, confidence interval.
[a]Limited to 482 adolescents with PTSD data available.
[b]Each model contains only the indicated WTC exposure variable along with the adjustment variables: demographics, number of adults in household, and smoker at home.
[c]One of family exposure components.

Calam et al. have shown reasonable concordance among parent-, teacher-, and adolescent-derived SDQ scores in UK adolescents.[41] Behavioral problems were more often observed in children of lower income, who lived in single-parent homes, or who were of Hispanic ethnicity. Children of parents with PTSD were at increased risk for behavioral difficulties, primarily driven by scores in the 2 internalizing behavior domains: peer problems and emotional symptoms. We also found that 26 (5.4%) of 482 adolescents with available data had probable PTSD. Normative prevalence data for PTSD among adolescents in New York City prior to 9/11 are limited, but performance testing of the DISC Version 2.3 in the early 1990s in 4 cities including New York City found a prevalence of 1.6% for any anxiety disorder using DSM-III-R criteria with diagnosis-specific impairment criteria.[42]

Our findings update by several years those of previous studies of 9/11 related mental health outcomes in children and suggest late-onset effects analogous to those reported in longitudinal studies of adults[5,43] that may not have been fully evident in studies of children closer in time to the event. Baseline data on 3,152 children in this Registry cohort suggested a PTSD prevalence of 3.2% in 2003–2004.[15] In New York Academy of Medicine surveys of NYC residents, parents of children aged 6–17 y reported fewer than "normal" problems 4 months post-9/11 and "normal" frequencies 6–9 months post-9/11. However, in a sub-sample of 161 adolescent children of respondents to the Academy survey up to 9 months post-9/11, the prevalence of probable PTSD was 12.6%.[14] Six months after 9/11 Hoven and colleagues found that 28.6% of 8,236 NYC schoolchildren in grades 4–12 had one of more of 6 probable anxiety/depressive disorders, and 10.6% had probable PTSD.[16] Eight months after 9/11, Calderoni et al. reported that 7.4% of 1,122 students in a high school 20 miles from Ground Zero had a PTSD symptom cluster (at least one re-experiencing, 2

Table 4. Adjusted Odds Ratios (AOR) and 95% Confidence Intervals (CI) for Association of Parental PTSD with Adolescent Total SDQ Score and Subscales Among 166 Enrollee Parent-adolescent Dyads

| Adolescent SDQ (score) | Parental probable PTSD[a] | | | | | |
| | Neither Wave (n = 131) | | Either Wave (n = 35) | | | |
	No.	(%)	No.	(%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]
Total						
Adolescent total SDQ score						
Normal (0–15)	116	(84.1)	22	(15.9)	referent	referent
Borderline/Abnormal	15	(53.6)	13	(46.4)	4.6 (1.9–10.9)	3.2 (1.1–8.8)
Internalizing subscales						
SDQ Peer problems						
Normal (0–3)	124	(86.1)	20	(13.9)	referent	referent
Borderline/Abnormal	7	(31.8)	15	(68.2)	13.3 (4.8–36.6)	23.5 (5.9–93.2)
SDQ Emotional symptoms						
Normal (0–5)	118	(83.1)	24	(16.9)	referent	referent
Borderline/Abnormal	13	(54.2)	11	(45.8)	4.2 (1.7–10.4)	3.6 (1.2–11.0)
Externalizing subscales						
SDQ Conduct problems						
Normal (0–3)	113	(80.7)	27	(19.3)	referent	referent
Borderline/Abnormal	18	(69.2)	8	(30.8)	1.9 (0.7–4.7)	1.1 (0.4–3.3)
SDQ Hyperactivity						
Normal (0–5)	112	(81.2)	26	(18.8)	referent	referent
Borderline/Abnormal	19	(67.9)	9	(32.1)	2.0 (0.8–5.0)	1.0 (0.3–2.9)

[a]PTSD was defined based on DSM-IV criteria and PCL scores $\geq$ 44.
[b]Each adolescent's SDQ total score and subscales, as an outcome variable, was examined separately in multivariate logistic regression, adjusted for adolescents' demographics, number of adults in household and smoker in the home.

Table 5. Adjusted Odds Ratio (AOR) and 95% Confidence Intervals (CI) for Association of Parental PTSD with Adolescent PTSD

| | Adolescent PTSD[a] | | | | | |
| | Yes (n = 8) | | No (n = 156) | | | |
	No.	(%)	No.	(%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]
Parental PTSD[c]						
Neither Wave (n = 130)	3	(2.3)	127	(97.7)	referent	referent
Either Wave (n = 34)	5	(14.7)	29	(85.3)	7.3 (1.7–32.3)	5.6 (1.1–28.4)

[a]Restricted to 164 parent-adolescent dyads with complete information for adolescent PTSD.
[b]Adjusted for adolescents' demographics, number of adults in household, and smoker in the home.
[c]PTSD was defined based on DSM IV criteria and PCL scores ≥ 44.

hyperarousal, and 3 avoidance symptoms).[17] Chemtob et al. surveyed 1,022 students in middle and high schools close to Ground Zero 18 months after 9/11 and reported prevalences of 4.4% for PTSD and just under 3% for depression.[19]

Thirty percent of the adolescents in our study reported having perceived a threat to, or feared for their own life or safety on 9/11, and 6% reported having a family member injured or killed as a result of the WTC attack. Loss of or injury to an adolescent's family member, and fear for his/her own life or safety were independently associated with behavioral difficulties. Adolescents' recall of their perceived safety on 9/11 may have been distorted by the impact of the event on their lives during the 6–7 y prior to being surveyed. Many families experienced common exposures including evacuation, destruction or heavy damage to living quarters, loss of parental employment and income, and abrupt changes in the child's social network.[21] Consequently, the constellation of "exposures" experienced by children often included a family environment in which one or both parents suffered 9/11 related health outcomes such as asthma, PTSD, or depression, and these may in turn have affected child mental health and behavior. Associations between parental PTSD and both behavioral and mental health problems in adolescents may also be a result of their witnessing and mirroring their parents' avoidant and anxious behaviors, and/or of an ensuing feedback loop within which distress in one triggers increased need and distress in the other.[44]

We observed strong associations between parental PTSD and adolescent behavior and PTSD. Effects of parental stress from 9/11 on child behavior have been reported in a number of other studies, some of which included very young children. In a study of 180 parents of children under age 5 at 11 NYC early childhood centers 9–12 months after 9/11, DeVoe and colleagues reported that 15% of parents sought mental health counseling for the child and that help seeking was associated with probable PTSD in the child and with parental symptoms of depression and anxiety.[22] Chemtob and colleagues studied behavior problems among 113 children attending preschools in close proximity to the WTC site. Children's behavior problems were reported by both their mothers and their preschool teachers 18 to 51 months (mean 35 months) after 9/11. The authors found that 9/11 exposed preschool children with mothers who suffered from both PTSD and depression had increased risk of emotional reactivity

(relative risk [RR] = 5.9 by mothers' and 3.4 by teachers' reports) and aggressive behavior problems (RR = 11.0 by mothers' and 5.9 by teachers' reports) relative to children whose mothers suffered from depression alone or neither disorder.[20] In a study by Stuber and colleagues, parental PTSD or depression was significantly associated with behavior problems in 6–11 y olds but not in 12–17 y olds 4 months after 9/11.[13] In the Columbia University NYC school study it was noted that 19.9% of the 288 schoolchildren with a family member employed as an emergency medical technician (EMT) had probable PTSD.[24] World Trade Center rescue and recovery workers participating in the WTC Medical Monitoring and Treatment Program 10 to 61 months after 9/11 *and* who had probable PTSD were more likely to report psychological symptoms and behavioral problems in their children compared to workers without PTSD.[23]

Our study has a number of strengths. We identified a large number of parent enrollees to allow analysis of parent-child mental health relationships, and used validated instruments: SDQ (parental report) has been used in 3 consecutive US National Health Interview Surveys[45] while the DPS was used in the Columbia University post-9/11 survey of over 8,000 NYC schoolchildren.[16] Eligibility for enrollment in the Registry was based on criteria for direct exposure that ensured larger proportions of directly exposed children than most other 9/11 studies. While exposure measures are based on self-report, numerous Registry studies have documented their associations with a variety of physical and mental health endpoints and provide evidence of substantial face validity.[3,46]

Among the limitations is that the 489 adolescents represent a response rate of 50%. Because enrollment in the registry is voluntary, findings may not be generalizable to all 9/11 exposed youth. The study does not include several hundred pediatric enrollees who reached their eighteenth birthday before Wave 2 data collection began; separate analyses of mental health outcomes in this older group are in progress. SDQ assessment was not done at baseline, so that change in degree of behavioral difficulties between the 2 waves could not be evaluated. We did not obtain a history of other traumatic events that might have affected risk for PTSD. Finally, while this study provides one of the most recent looks at this vulnerable population, it still brings us only to 2008. Data from the Registry's Wave 3 survey, completed in 2012, will appear in future reports.

Our findings may be of clinical as well as epidemiological interest. In 2009 the Registry, with community and academic input, published clinical guidelines for pediatricians and other medical personnel treating children and adolescents who may have been affected by 9/11 experiences.[47] In this regard it is noteworthy that many parents were clearly aware of their child's potential problems, since borderline or abnormal SDQ was more common in children whose parents had consulted a professional about a child's problem. These new findings, based on children observed for up to 7 y to 5 y after initial assessment, may occasion a review and update of the guidelines. The correlations between parent and child mental health symptoms highlight the need for post-disaster training for healthcare practitioners that emphasizes the role of family-based prevention and treatment options as a part of planning for and response to other types of disasters, especially those in which family members collectively undergo traumatic exposures and experiences, and for sustained and repeated post-disaster screening efforts over the long term where possible.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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