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ARTICLE

Posttraumatic stress disorder in the short and medium term following the World Trade Center attack among Asian Americans

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Abstract

This study investigated patterns of probable posttraumatic stress disorder (PTSD) and their predictors among 2,431 Asian American and 31,455 non-Hispanic White World Trade Center (WTC) Registry participants 2–3 years and 5–6 years after the WTC attack. Participants were divided into four PTSD pattern groups: resilient, remitted, delayed onset, and chronic. Asians had a lower proportion in the resilient group (76.5% vs. 79.8%), a higher proportion in the chronic (8.6% vs. 7.4%) and remitted (5.9% vs. 3.4%) groups, and a similar proportion in the delayed onset group (about 9%) compared to Whites. In multinomial logistic regression analyses, disaster exposure, immigrant status, lower income, pre-attack depression/anxiety, and lower respiratory symptoms were associated with increased odds of chronic and delayed onset PTSD (vs. resilience) among both races. Education and employment were protective against chronic and delayed onset PTSD among Whites only. These results can inform targeted outreach efforts to enhance prevention and treatment for Asians affected by future events.

Although 16 years have lapsed since the terrorist attack at the World Trade Center (WTC) on September 11, 2001 (hereinafter referred to as 9/11), a substantial number of people who were directly exposed to the disaster are still suffering from physical as well as psychological problems (Jordan et al., 2015; Maslow et al., 2015). Posttraumatic stress disorder (PTSD) is one of the persisting mental health issues that continue to affect many survivors. A considerable number of Asians were exposed to the attack, as the WTC was less than 10 blocks away from Chinatown and many South Asians worked at the collapsed and nearby buildings (Asian American Federation of New York, 2003). While numerous studies have documented psychological distress associated with the attack among specific affected groups, such as rescue and recovery workers (Bowler et al., 2012; Cone et al., 2015), survivors of the collapsed buildings (DiGrande, Neria, Brackbill, Pulliam, & Galea, 2011), and Lower Manhattan residents (Welch et al., 2016), very few have focused on Asian Americans.

Previous U.S. epidemiological studies have reported higher prevalence of PTSD among minorities such as Africans and Hispanics compared to their European counterparts, but Asians exhibited a lower prevalence of PTSD (Alegria et al., 2013; Pole, Gone, & Kulkarni, 2008). WTC-related studies show a more complex picture. Studies that included broader samples of New York City residents who might or might not have been directly affected by the attack found that being Asian was a protective factor for PTSD compared to other racial groups (e.g., Bonanno, Galea, Bucciarelli, & Vlahov, 2007; Galea et al., 2002). However, based on the WTC Health Registry (hereinafter referred to as the Registry) data–the largest study of individuals directly exposed to the attack–investigations across participant categories (responders, nearby workers, residents, and passers-by) demonstrated that Asians had a higher prevalence of PTSD compared to Whites (Bowler et al., 2010; Farfel et al., 2008), with the exception of Lower Manhattan residents (DiGrande et al., 2008). Using the Registry data at a cross-sectional time point collected 2–3 years after the attack, our team conducted the first study that focused on all Asian American Registry participants. Results also indicated that PTSD was more prevalent among Asians compared to Whites and that factors associated with PTSD may differ between racial groups (Kung, Liu, Huang, Kim, & Yang, in press).

A review of 9/11 disaster-related PTSD studies observed that these studies mainly reported findings within the first couple of years after the attack and that longitudinal data are lacking (Neria, DiGrande, & Adams, 2011). Investigations tracking the continued development of PTSD are important because its manifestation could be delayed for 6 years and beyond following a life-threatening event (Bowler et al., 2012). Although most studies after the attack have demonstrated diminishing PTSD symptoms with the passage of time (e.g., Galea et al., 2002), some panel studies in which the same participants were recruited over time (e.g., firefighters and police) reported increased PTSD symptoms with time (Bowler et al., 2012).

The longitudinal design of the Registry has facilitated more recent prospective examination of probable PTSD over the years after the attack and its predictors, including studies investigating rescue and recovery workers (Maslow et al., 2015) and Lower Manhattan residents and area workers (Welch et al., 2016). However, the experience of Asians has not yet been examined. We are aware of only one longitudinal study that reported the mental health impact of 9/11 on displaced Chinese garment workers 8 months and 18 months after the attack with a small sample (n = 148). The study found that probable PTSD rose from 21% to 27% in less than a year (de Bocanegra, Moskalenko, & Kramer, 2006). However, longer term patterns in PTSD as well as risk and protective factors of these patterns have not yet been reported among Asians. This is particularly important given the relatively low mental health service use among Asians compared to all other racial groups (Sue, Yan Cheng, Saad, & Chu, 2012; U.S. Department of Health and Human Services, 2001).

The aim of this investigation is to advance prior literature by building upon our previous cross-sectional work among Asian Registry participants. We examined PTSD at two time points following the attack—2–3 years (Wave 1, as baseline) and 5–6 years post-9/11 (Wave 2)—and we evaluated factors associated with PTSD status change over time. Based on the two time points, we conceptually identified four PTSD groups, as informed by previous studies (e.g., Pietrzak et al., 2014)–resilient, remitted, delayed onset, and chronic–and we examined factors associated with PTSD group status among Asians, using Whites as a reference group. We hypothesized that lower socioeconomic status, higher disaster exposure, and the presence of physical and mental comorbidity would be associated with poorer PTSD outcomes (i.e., in chronic or delayed onset groups) and that socioeconomic status would be particularly important for Asian participants, given the effects of the economic downturn in Chinatown and discrimination faced by South Asians being mistaken as Muslims in the aftermath of 9/11 (Asian American Federation of New York, 2003). The ultimate goal of the study is to inform targeted outreach efforts to more vulnerable Asian subgroups for mental health treatment.

1 | METHOD

1.1 | WTC health registry study

The current investigation was based on data from the Registry, which was funded by the U.S. Federal Emergency Management Agency and developed in 2002 to evaluate the long-term health effects of the WTC attack (Farfel et al., 2008).

Baseline data were collected in 2003 and 2004, 2–3 years after the disaster (Wave 1), from 71,433 adult enrollees. Three additional waves of data were collected 5–6 years (Wave 2), 10–11 years and 14–15 years afterwards. This study used Wave 1 and Wave 2 data; given Asians' lower tendency to acknowledge mental health needs (Leong & Lau, 2001), enhanced, targeted outreach efforts to increase mental health service use in the short and medium term are particularly important to prevent long-term psychopathology in this population. Participants included rescue and recovery workers, workers in the WTC and nearby buildings, passers-by, and residents in Lower Manhattan. Full details on the Registry are described elsewhere (Brackbill et al., 2006). We obtained institutional review board approvals from the Center for Disease Control and Prevention (the first author's university) and the New York City Department of Health and Mental Hygiene.

1.2 | Participants

The Wave 1 sample comprised 4,885 Asian and 43,712 White participants aged ≥18 years. Exclusion criteria for the study were as follows: those who did not participate in both waves; those who, although included in the Registry, were deceased (information was provided by proxies but did not include the PTSD measure); those who were ≥90 years of age (with no specific age given); those who had a pre-9/11 PTSD diagnosis (with high recurrence risk after another trauma overshadowing more recent factors; Cukor et al., 2011); or those without imputable PTSD measures at Wave 1 or Wave 2 (see the Measures section). The analytic sample included 2,431 Asians and 31,455 Whites.

1.3 | Measures

PTSD We examined probable PTSD using the PTSD Checklist, Civilian Version (PCL-C; Weathers, Litz, Herman, Huska, & Keane, 1993), specifically worded to assess 9/11-related symptoms. The scale is a self-reported, 17-item validated measure inquiring about symptomology in the last 30 days, based on the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev, American Psychiatric Association, 2000) criteria. Responses ranged from 1 (not at all) to 5 (extremely), with a higher score indicating more PTSD symptomology. Responses were summed across the 17 items, and a validated cutoff score of 44 was used to indicate probable PTSD (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996), hereafter referred to as PTSD. For PCL scores with missing values, if the sum already exceeded 44, they were coded as having PTSD. Otherwise, imputation with the highest score (5) for the missing value was used. If the new score resulted in a sum ≤ 44, the participant was considered not to have PTSD, and if it was higher, it would be considered missing and excluded from the study. The final missing constituted to 3.7% for Asians and 0.64% for Whites.

This procedure was used to conservatively preserve cases who would not meet the cutoff for having PTSD and would otherwise be excluded from the study. To classify cases into PTSD groups that indicate status in both Wave 1 and Wave 2, participants who had PCL-C scores < 44 in both waves were considered resilient; those with scores ≥44 in Wave 1 but < 44 in Wave 2 were considered "remitted"; those with scores < 44 in Wave 1, but ≥ 44 in Wave 2 were considered delayed onset; and those with scores ≥44 in both waves were considered chronic.

Disaster exposure A composite score quantifying direct disaster exposure was derived by summing endorsements at Wave 1 of the following types of experiences: located in a damaged/collapsed building during the attack; witnessed ≥ 3 horrific events (e.g., saw a plane hit a tower); exposed to dust cloud; sustained any injury (excluding eye irritation); was a rescue/recovery worker; and feared being injured/killed. This *direct exposure* variable was then grouped into 0–1, 2–3, and 4–6 exposures based on the distribution of this variable in the study sample. Three additional dichotomous exposure variables collected at Wave 2 were examined: *loss of job* attributed to events of 9/11; *lost someone* (a relative, friend, or coworker) in the disaster; and *tangible loss* which included damage to home, workplace, and evacuation from home for ≥48 hours.

Lower respiratory symptoms (LRS) Respondents were classified as having LRS symptoms if they reported new or worsening symptoms for one or more of the following symptoms: shortness of breath, persistent coughing, and wheezing from 9/11 to Wave 1. This variable was included because previous studies have linked LRS with increased PTSD (Friedman et al., 2013; Neria et al., 2011).

Recruitment source Being self-identified or list-identified when recruited into the Registry was controlled for in the analyses because previous studies have demonstrated that the former tended to have more health concerns (Brackbill et al., 2009).

Pre-9/11 depression or anxiety diagnosis This dichotomous variable was defined as positive if respondents reported being diagnosed with depression or an anxiety disorder other than PTSD by a doctor or other mental health professional prior to 9/11.

Demographic characteristics Selected baseline demographic characteristics included in the analysis were age, gender, educational attainment, yearly income, and employment status.

1.4 | Statistical analyses

We calculated summary statistics (frequency, percent) to describe participants' demographic, disaster-related, and clinical characteristics separately for each race and used chi-square test to detect racial differences in the distribution of these variables. We also examined the distribution of PTSD status group by each of the Wave 1 factors of interest and used Chi-square test to detect bivariate associations for each race separately. To further examine the independent association between the different factors and PTSD status group, we applied multinomial logistic regression models for Asians and Whites separately. From the estimated model parameters, we derived covariate-adjusted odds ratios (AOR) and 95% confidence intervals (CI) by comparing each PTSD group to the resilient group as the reference. We used the Wald test to detect racial differences in the model parameters for the AOR and then adjusted p values for multiple testing to control for family-wide error rate using the Hochberg method (Hochberg, 1988; Hochberg & Benjamini, 1990). Significance level of statistical tests was set at 0.05. All analyses were conducted using SAS (v.9.4).

2 | RESULTS

Table 1 reports the distribution of participant characteristics for Asian and White participants. The majority of Asians were in the prime years (25–44, 49.1%) or mid-years of their lives (45–64, 35.6%). The Asian group comprised a slightly greater proportion of males (53.2%) than the White group. One fourth of Asians had high school or less education and about 60% had college or more training, but overall this group skewed toward lower incomes (38.0% < $50,000) compared to the White group. Of the Asian group, 77.2% were employed and two-thirds were married/cohabiting. Compared to the White group, a larger proportion of Asians were younger (18–24 years), older (≥65 years), females, and never married. A slightly smaller proportion of Asians were married/cohabiting compared to the White group. Overall, Asians were less educated than Whites, with a higher proportion of participants being high school educated or less (24.3% vs. 19.0%) and a lower proportion having "some college/technical training" (14.6% vs. 23.1%). Compared to the White group, more than twice the proportion of Asians reported earning < $50,000 (38.0% vs. 18.3%) and a lower proportion were employed (77.2% vs. 86.6%). Last, half of Asians were immigrants, which contrasted with only 6.0% among the White group.

Asians had fewer direct disaster exposures than Whites (54.0% vs. 61.0% with ≥ 2 exposures). A larger proportion of Asians lost their jobs (11.6% vs. 6.8%) as well as their possessions (13.0% vs. 11.3%), but a higher proportion of Whites had lost a relative, friend, or coworker due to 9/11 (28.8% vs. 15.5%). About 53% of both races had LRS at baseline, while a lower proportion of Asians reported a pre-9/11 depression/anxiety disorder compared to Whites (3.4% vs. 9.8%). A slightly higher proportion of Asians self-identified during recruitment compared to Whites (76.0% vs. 72.9%).

Racial differences were noted for the overall PTSD status group distribution (p < 0.001). Over three fourths of participants from both races were resilient, although a slightly lower proportion of Asians were resilient compared to Whites (76.5% vs. 79.8%). Compared to Whites, a higher proportion of Asians were in the chronic (8.6% vs. 7.4%) and remitted groups (5.9% vs. 3.4%). A considerable proportion of participants from both races had delayed onset (9.1% Asians vs. 9.4% Whites).

TABLE 1 Wave 1 Participant demographic, clinical, and disaster-related characteristics among Asian and White World Trade Center registry participants

	Asian (n = 2,431) % (n)	White (n = 31,455) % (n)
PTSD status group[**]:		
Resilient	76.47 (1859)	79.83 (25112)
Remitted	5.88 (143)	3.42 (1076)
Delayed	9.09 (221)	9.36 (2943)
Chronic	8.56 (208)	7.39 (2324)
Age[**]:		
18–24	6.42 (156)	2.89 (909)
25–44	49.12 (1194)	47.11 (14820)
45–64	35.62 (866)	45.28 (14243)
65+	8.84 (215)	4.71 (1483)
Gender[**]:		
Male	53.19 (1293)	66.69 (20976)
Female	46.81 (1138)	33.31 (10479)
Education[**]:		
High school or less	24.43 (594)	18.96 (5964)
Some college/technical school	14.64 (356)	23.12 (7271)
College graduate	36.65 (891)	34.33 (10797)
Professional/graduate school	23.65 (575)	23.38 (7335)
Missing	0.62 (15)	0.22 (68)
Income[**]:		
< $50,000	38.01 (924)	18.30 (5755)
$50,000– < $75,000	17.11 (416)	19.36 (6090)
$75,000– < $100,000	11.97 (291)	19.82 (6234)
$100,000 or more	20.73 (504)	32.69 (10284)
Missing	12.18 (296)	9.83 (3092)
Employment status[**]:		
Unemployed/unreported	22.83 (555)	13.37 (4204)
Employed	77.17 (1876)	86.63 (27251)
Marital status[**]:		
Married/cohabiting	65.69 (1597)	69.83 (21965)
Divorced/widowed/separated	9.71 (236)	10.52 (3309)
Never married	23.86 (580)	19.39 (6098)
Missing	0.74 (18)	0.26 (83)
Immigration status[**]:		
United States born	49.98 (1215)	94.04 (29581)
Immigrant/unreported	50.02 (1216)	5.96 (1874)
Recruitment source[**]:		
List-identified	23.98 (583)	27.08 (8519)
Self-identified	76.02 (1848)	72.92 (22936)

(Continues)

TABLE 1 Continued

	Asian (n = 2,431) % (n)	White (n = 31,455) % (n)
Direct exposure[**]:		
0–1	46.03 (1119)	38.96 (12255)
2–3	40.85 (993)	42.72 (13438)
4–6	13.12 (319)	18.32 (5762)
Job loss due to 9/11[**]:		
No	87.21 (2120)	92.27 (29025)
Yes	11.60 (282)	6.77 (2128)
Missing	1.19 (29)	0.96 (302)
Lost someone on 9/11[**]:		
No	84.53 (2055)	71.18 (22390)
Yes	15.47 (376)	28.82 (9065)
Tangible loss[*]:		
No or missing	87.00 (2115)	88.71 (27905)
Yes	13.00 (316)	11.29 (3550)
Lower respiratory symptoms:		
No or Missing	47.14 (1146)	47.47 (14932)
Yes	52.86 (1285)	52.53 (16523)
Pre-9/11 depression/anxiety[**]:		
No	87.87 (2136)	87.10 (27397)
Yes	3.41 (83)	9.76 (3070)
Missing	8.72 (212)	3.14 (988)

[*]$p < 0.05.$ [**]$p < 0.001.$

Table 2 presents the distribution of PTSD status group by demographic, disaster-related, and clinical factors for each race. PTSD group was significantly associated with all factors for both races ($p < 0.05$), with the exception of gender and employment status for Asians. We noted the following resilience factors among the Asian group: a higher proportion of the youngest (85.3% aged 18–24 years) and oldest (82.3% aged ≥65 years) participants; higher education and income; never married (83.5%) and married/cohabiting (75.6%); U.S. born (80.3%); and list-identified in recruitment (81.5%). In contrast, chronic PTSD was noted among Asians who were the oldest (11.9% aged 45–64 years); had the lowest income (< $50,000, 11.4%); were divorced/widowed/separated (13.5%); were of immigrant status (10.2%); and self-identified in recruitment (9.4%). Similar trends were found for delayed onset PTSD.

Compared to Whites, greater disaster exposure among Asians was associated with lower prevalence of resilience, with the proportion of participants in the resilient group falling from 85.9% to 52.4% as the number of direct exposures increased from 0–1 to 4–6. Exposure to 9/11-related job loss was also associated with a lower proportion in the resilient group than those not exposed to such job loss (51.8% vs. 80.0%), but there was a higher proportion in the chronic (23.8% vs. 6.5%) and delayed onset (15.3% vs. 8.1%) groups. A similar trend was observed for having lost someone or experiencing tangible loss in 9/11, although the difference in proportions between those exposed and unexposed to these experiences was smaller. Having LRS or pre-9/11 depression/anxiety disorder was associated with a lower prevalence of resilience versus not having such health or mental health issues, while the opposite was true in the chronic and delayed onset groups.

For Whites, similar to Asians, having more advantaged socioeconomic status was associated with being resilient, and having disadvantaged status was associated with poorer PTSD status. However, the associations were stronger and the patterns clearer in Whites than Asians. For example, in both races the proportion of the resilient group increased with

TABLE 2 Wave 1 to Wave 2 prevalence of probable PTSD status groups by Wave 1 factors among Asian and White World Trade Center registry participants

	Asian (n = 2,431)			White (n = 31,455)		
	Resilient % (n)	Chronic % (n)	Delayed % (n)	Resilient % (n)	Chronic % (n)	Delayed % (n)
Age[**]:						
18–24	85.26 (133)	2.56 (4)	9.62 (15)	83.28 (757)	4.95 (45)	8.03 (73)
25–44	78.98 (943)	7.79 (93)	8.04 (96)	79.58 (11794)	7.18 (1064)	9.79 (1451)
45–64	69.98 (606)	11.89 (103)	10.16 (88)	79.04 (11258)	8.03 (1144)	9.51 (1354)
65+	82.33 (177)	3.72 (8)	10.23 (22)	87.86 (1303)	4.79 (71)	4.38 (65)
Gender[*]:						
Male	77.11 (997)	8.58 (111)	9.36 (121)	80.60 (16907)	6.62 (1388)	10.03 (2104)
Female	75.75 (862)	8.52 (97)	8.79 (100)	78.30 (8205)	8.93 (936)	8.01 (839)
Education[**]:						
High school or less	70.03 (416)	8.75 (52)	14.31 (85)	72.64 (4332)	11.44 (682)	11.45 (683)
Some college/technical school	75.56 (269)	8.43 (30)	9.83 (35)	76.89 (5591)	8.60 (625)	11.15 (811)
College graduate	78.34 (698)	8.75 (78)	7.07 (63)	81.78 (8830)	6.41 (692)	8.72 (941)
Professional/graduate school	81.04 (466)	8.00 (46)	6.43 (37)	85.85 (6314)	4.30 (316)	6.74 (496)
Missing	66.67 (10)	13.33 (2)	6.67 (1)	66.18 (45)	13.24 (9)	17.65 (12)
Income[**]:						
< $50,0000	69.37 (641)	11.36 (105)	12.23 (113)	73.33 (4220)	12.20 (702)	9.63 (554)
$50,000– < $75,0000	77.16 (321)	8.89 (37)	7.69 (32)	77.03 (4691)	8.26 (503)	10.94 (666)
$75,000– < $100,000	80.07 (233)	5.84 (17)	8.93 (26)	80.01 (4988)	6.67 (416)	10.31 (643)
$100,000 or more	85.12 (429)	6.35 (32)	4.96 (25)	83.96 (8634)	5.12 (527)	8.27 (850)
Missing	79.39 (235)	5.74 (17)	8.45 (25)	83.41 (2579)	5.69 (176)	7.44 (230)
Employment status[*]:						
Unemployed/unreported	76.22 (423)	9.01 (50)	9.55 (53)	73.12 (3074)	13.42 (564)	9.47 (398)
Employed	76.55 (1436)	8.42 (158)	8.96 (168)	80.87 (22038)	6.46 (1760)	9.34 (2545)
Marital status[**]:						
Married/cohabiting	75.58 (1207)	8.83 (141)	9.33 (149)	81.43 (17887)	6.38 (1401)	9.18 (2017)
Divorced/widowed/separated	66.53 (157)	13.56 (32)	12.71 (30)	70.35 (2328)	13.36 (442)	11.18 (370)
Never married	83.45 (484)	5.69 (33)	6.72 (39)	79.42 (4843)	7.69 (469)	8.90 (543)
Missing	61.11 (11)	11.11 (2)	16.67 (3)	65.06 (54)	14.46 (12)	15.66 (13)
Immigration status[**]:						
United States born	80.33 (976)	6.91 (84)	7.49 (91)	80.17 (23714)	7.22 (2137)	9.35 (2765)
Immigrant/unreported	72.62 (883)	10.20 (124)	10.69 (130)	74.60 (1398)	9.98 (187)	9.50 (178)
Recruitment source[**]:						
List-identified	81.48 (475)	5.83 (34)	7.38 (43)	85.44 (7279)	4.81 (410)	7.09 (604)
Self-identified	74.89 (1384)	9.42 (174)	9.63 (178)	77.75 (17833)	8.34 (1914)	10.20 (2339)
Direct exposure[**]:						
0–1	85.88 (961)	3.31 (37)	7.24 (81)	90.49 (11089)	2.51 (307)	5.33 (653)
2–3	73.62 (731)	9.47 (94)	9.67 (96)	78.07 (10491)	7.67 (1031)	10.27 (1380)
4–6	52.35 (167)	24.14 (77)	13.79 (44)	61.30 (3532)	17.11 (986)	15.79 (910)

(Continues)

TABLE 2 Continued

	Asian (n = 2,431)			White (n = 31,455)		
	Resilient % (n)	**Chronic % (n)**	**Delayed % (n)**	**Resilient % (n)**	**Chronic % (n)**	**Delayed % (n)**
Job loss due to 9/11[**]:						
No	80.00 (1696)	6.51 (138)	8.07 (171)	82.08 (23823)	5.89 (1709)	8.81 (2557)
Yes	51.77 (146)	23.76 (67)	15.25 (43)	50.05 (1065)	27.11 (577)	16.73 (356)
Missing	58.62 (17)	10.34 (3)	24.14 (7)	74.17 (224)	12.58 (38)	9.93 (30)
Lost someone on 9/11[**]:						
No	78.69 (1617)	7.15 (147)	8.61 (177)	83.03 (18591)	5.86 (1312)	7.73 (1730)
Yes	64.36 (242)	16.22 (61)	11.70 (44)	71.94 (6521)	11.16 (1012)	13.38 (1213)
Tangible loss[**]:						
No or Missing	77.21 (1633)	7.71 (163)	8.94 (189)	80.96 (22592)	6.83 (1906)	8.91 (2486)
Yes	71.52 (226)	14.24 (45)	10.13 (32)	70.99 (2520)	11.77 (418)	12.87 (457)
Lower respiratory symptoms[**]:						
No or Missing	87.43 (1002)	2.71 (31)	6.63 (76)	91.08 (13600)	2.30 (343)	4.90 (732)
Yes	66.69 (857)	13.77 (177)	11.28 (145)	69.67 (11512)	11.99 (1981)	13.38 (2211)
Pre-9/11 depression/anxiety[**]:						
No	78.75 (1682)	7.68 (164)	7.96 (170)	81.43 (22310)	6.68 (1830)	8.80 (2411)
Yes	55.42 (46)	10.84 (9)	24.10 (20)	70.85 (2175)	11.40 (350)	11.92 (366)
Missing	61.79 (131)	16.51 (35)	14.62 (31)	63.46 (627)	14.57 (144)	16.80 (166)

Note. The p-values were based on Chi-square tests of the four trajectory groups; the remitted group is not presented. *p < 0.05 for Whites but not for Asians. **p < 0.05 for both Whites and Asians.

education, but the decreasing trend in the proportion of the chronic group with increasing education was apparent in Whites but not in Asians.

Table 3 presents results from the multinomial logistic regression models comparing odds of chronic and delayed onset PTSD versus resilience among Asians and Whites. The association between education and chronic PTSD (vs. resilience) differed between races. The odds of chronicity significantly decreased with education in Whites (e.g., for college graduates AOR = 0.57; 95% CI [0.50, 0.64]), but the direction of the association was opposite for Asians and nonsignificant (AOR = 1.09; 95% CI [0.67, 1.76]). For Asians, significant protective demographic factors against chronic PTSD included age ≥65 (AOR = 0.34, 95% CI [0.14, 0.81]), annual household income ≥$50,000 (AOR range = 0.32-0.52, all p < 0.05), and never married versus married/cohabiting (AOR = 0.61; 95% CI [0.37, 0.99]).

Exposure-related factors were significantly associated with increased odds of chronic PTSD among Asians: Direct disaster exposure incurred the highest odds for those with 2–3 and 4–6 exposures versus 0–1 exposure (AOR = 4.14, 95% CI [2.68, 6.42], and AOR = 10.19, 95% CI [6.14, 16.93], respectively). Other exposures doubled the odds, including job loss due to 9/11 (AOR = 2.64, 95% CI [1.76, 3.96]), having lost someone (AOR = 1.99, 95% CI [1.34, 2.94]), and having had a tangible loss (AOR = 1.81, 95% CI [1.18, 2.76]). Having LRS (AOR = 4.59, 95% CI [3.02, 6.97]) and pre-9/11 mental disorder diagnoses (AOR = 2.38, 95% CI [1.04, 5.43]) were also associated with increased odds of chronic PTSD. For Whites, all baseline factors were significantly associated with odds of chronic PTSD versus being resilient with patterns similar to Asians for most factors. However, the impact of 9/11-related job loss appeared more profound in Whites than in Asians (AOR = 4.30, 95% CI [3.77, 4.89] vs. AOR = 2.64, 95% CI [1.76, 3.96]), although the racial differences became nonsignificant when adjusting for multiple testing.

For the delayed onset versus resilient group comparison, the only factor that showed a significant racial difference after multiple testing adjustment was pre-9/11 mental disorder diagnoses (p = 0.05), which showed a stronger association among Asians than Whites (AOR = 4.77, 95% CI [2.62, 8.66] vs. AOR = 1.92, 95% CI [1.69, 2.18]). For Asians,

TABLE 3 Adjusted odds ratio (AOR) and 95% confidence interval (CI) for associations between Wave 1 factors and Wave 1 to Wave 2 PTSD status group among Asian and White World Trade Center registry participants

	Chronic vs. Resilient		Delayed vs. Resilient	
	Asian (n = 2,431) AOR [95% CI]	White (n = 31,455) AOR [95% CI]	Asian (n = 2,431) AOR [95% CI]	White (n = 31,455) AOR [95% CI]
Age (Ref. 25–44):				
18–24	0.72 [0.23, 2.24]	0.68 [0.49, 0.96]	1.87 [0.91, 3.87]	1.03 [0.79, 1.34]
45–64	1.38 [0.96, 1.98]	1.02 [0.93, 1.13]	1.02 [0.72, 1.43]	0.97 [0.90, 1.06]
65+	0.34 [0.14, 0.81]	0.40 [0.30, 0.54]	0.74 [0.40, 1.38]	0.43 [0.32, 0.56]
Gender (Ref. Male):				
Female	1.13 [0.81, 1.59]	1.53 [1.38, 1.70]	0.90 [0.66, 1.23]	0.93 [0.84, 1.02]
Education (Ref. High school or less)*[a]:				
Some college/technical school	0.98 [0.54, 1.74]	0.66 [0.58, 0.75]	0.63 [0.39, 1.03]	0.86 [0.76, 0.96]
College graduate	1.09 [0.67, 1.76]	0.57 [0.50, 0.64]	0.49 [0.32, 0.75]	0.74 [0.67, 0.84]
Professional/graduate school	1.11 [0.64, 1.92]	0.40 [0.34, 0.47]	0.51 [0.31, 0.83]	0.61 [0.53, 0.69]
Income (Ref. < $50k):				
$50k– < $75k	0.52 [0.32, 0.84]	0.65 [0.57, 0.75]	0.64 [0.40, 1.03]	0.96 [0.84, 1.09]
$75k– < $100k	0.33 [0.18, 0.61]	0.51 [0.44, 0.59]	0.69 [0.41, 1.15]	0.82 [0.72, 0.94]
$100k or more	0.32 [0.19, 0.54]	0.44 [0.39, 0.52]	0.37 [0.22, 0.63]	0.71 [0.63, 0.81]
Employment status (Ref. Unemployed/unreported):				
Employed	0.81 [0.53, 1.24]	0.55 [0.49, 0.63]	1.20 [0.80, 1.81]	0.89 [0.78, 1.00]
Marital status (Ref. Married/cohabiting):				
Divorced/widowed/separated	1.40 [0.85, 2.29]	1.59 [1.39, 1.83]	1.36 [0.86, 2.17]	1.27 [1.11, 1.44]
Never married	0.61 [0.37, 0.99]	1.00 [0.87, 1.14]	0.60 [0.38, 0.97]	0.96 [0.85, 1.08]
Immigration status (Ref. United States born):				
Immigrant/unreported	1.26 [0.90, 1.75]	1.59 [1.33, 1.90]	1.41 [1.04, 1.92]	1.19 [1.01, 1.41]
Referral (Ref. List-referred):				
Self-referred	1.27 [0.82, 1.94]	1.23 [1.08, 1.39]	1.22 [0.84, 1.78]	1.11 [1.00, 1.23]

(Continues)

TABLE 3 Continued

	Chronic vs. Resilient		Delayed vs. Resilient	
	Asian (n = 2,431) AOR [95% CI]	White (n = 31,455) AOR [95% CI]	Asian (n = 2,431) AOR [95% CI]	White (n = 31,455) AOR [95% CI]
Direct exposure (Ref. 0–1):				
2-3	4.14 [2.68, 6.42]	2.70 [2.35, 3.10]	2.08 [1.47, 2.93]	1.78 [1.61, 1.98]
4-6	10.19 [6.14, 16.93]	6.24 [5.37, 7.24]	3.61 [2.26, 5.76]	2.82 [2.51, 3.18]
Job loss due to 9/11 (Ref. No)[*a]:				
Yes	2.64 [1.76, 3.96]	4.30 [3.77, 4.89]	1.78 [1.18, 2.69]	2.33 [2.03, 2.66]
Lost someone on 9/11 (Ref. No):				
Yes	1.99 [1.34, 2.94]	1.44 [1.30, 1.60]	1.64 [1.10, 2.42]	1.38 [1.26, 1.51]
Tangible loss (Ref. No or missing):				
Yes	1.81 [1.18, 2.76]	1.51 [1.32, 1.71]	1.27 [0.83, 1.95]	1.46 [1.30, 1.64]
Lower respiratory symptoms (Ref. Not reported)[a]:**				
Reported	4.59 [3.02, 6.97]	4.62 [4.08, 5.23]	1.82 [1.33, 2.49]	2.72 [2.48, 2.98]
Pre-9/11 depression/anxiety (Ref. No)[**]:				
Yes	2.38 [1.04, 5.43]	2.24 [1.94, 2.58]	4.77 [2.62, 8.66]	1.92 [1.69, 2.18]

Note. AOR = adjusted odds ratio derived from race-specific multinomial logistic models. Remitted vs. resilient comparison not presented.
[a]p-value became nonsignificant at the 0.05 level after multiple testing adjustment.
*p < 0.05 for racial differences, chronic PTSD vs. resilience. **p < 0.05 for racial differences, delayed-onset PTSD vs. resilience

in addition to the significant factors of income, marital status, disaster exposure, and other health and mental health issues identified in the chronic versus resilient comparisons above, having a college degree or graduate training was significantly protective (AOR = 0.49, 95% CI [0.32, 0.75] and AOR = 0.51, 95% CI [0.31, 0.83]); being an immigrant (AOR = 1.41, 95% CI [1.04, 1.92]), having lost someone in 9/11 (AOR = 1.64, 95% CI [1.10, 2.42]), or having job loss due to 9/11 (AOR = 1.78, 95% CI [1.18, 2.69]) were also significantly associated with the odds of having delayed onset. These patterns were similar for Whites, but the association between pre-9/11 depression anxiety and delayed onset PTSD was stronger for Asians (AOR = 4.77, 95% CI [2.62, 8.66]) compared to Whites (AOR = 1.92, 95% CI [1.69, 2.18]).

In an additional analysis examining the association between these factors and having chronic versus delayed onset PTSD (not shown in the tables), higher income and being employed were associated with lower odds of chronic versus delayed onset PTSD, and direct exposure and LRS were associated with higher odds of chronic versus delayed onset PTSD in both racial groups. However, higher education was associated with greater odds of chronic versus delayed onset PTSD for Asians, but it was associated with lower odds of chronic versus delayed onset PTSD for Whites. Being an immigrant was associated with greater odds of chronic versus delayed onset PTSD among Whites, but the association was not observed among Asians.

3 | DISCUSSION

The unique contribution of this study is that it provides information on the factors associated with short- to medium-term PTSD status change on Asian Americans after the WTC attack using a large sample and a comparison group. This is important because PTSD can emerge and linger for many years after a traumatic event (Bowler et al., 2012). Using Wave 1 data, we are better able to examine factors associated with PTSD group membership, which can inform outreach efforts to vulnerable subgroups for future prevention and follow-up treatment. This is especially important for Asian Americans, given patterns of substantial underutilization of mental health services in this population (U.S. Department of Health and Human Services, 2001).

Although all of the participants had been exposed to the WTC attack, the large majority was resilient to developing PTSD 5–6 years after the attack, consistent with previous studies (Brackbill et al., 2009). Still, 17.7% of Asians and 16.8% of Whites were suffering from PTSD (including those with chronic and delayed onset conditions) at 5–6 years post-9/11. Worth noting is that close to 10% of participants (Asian: 9.1%; Whites: 9.4%) had delayed onset PTSD. This points to the importance of early outreach and follow-up treatment even when initial PTSD symptoms do not reach the clinical threshold. We found that the delayed onset group had higher PCL scores at baseline compared to the resilient group for both Asians and Whites (32.4 vs. 25.3 and 32.8 vs. 34.5, respectively, p < 0.001 for both, not shown in tables), also consistent with previous studies (Bowler et al., 2012).

Significant though small differences in PTSD status group were detected between the races, with Asians having a slightly lower proportion in the resilient group and a higher proportion in the chronic group compared to Whites. This finding, although concordant with the results from our Wave 1 cross-sectional study indicating a higher PTSD prevalence among Asians, contrasted with general epidemiological studies that have indicated a lower proportion of PTSD among Asians compared to all other racial groups (Alegria et al., 2013; Roberts, Gilman, Breslau, Breslau, & Koenen, 2011). Our findings thus challenge the "model minority" myth which states that Asians are less likely to have mental health issues or other social problems (Sue et al., 2012). Our contrasting findings might partly be attributed to the greater inclusion of non-English speaking Asians with lower socioeconomic status, which was achieved in this study through more outreach efforts using interviewers with Asian language capability, than has been used in many general epidemiological studies (Sue et al., 2012).

The socioeconomic status of Asian and White participants at baseline were significantly different, with Asians having lower education and income, a lower proportion being employed, and a higher proportion being immigrants, putting them in a more disadvantaged position to cope with the disaster. As hypothesized, the general trend of our findings for both races pointed to the association between advantaged socioeconomic status and resilience and disadvantaged status with chronic and delayed onset PTSD. While larger proportions of individuals with higher

education were in the resilient group across racial groups, the protective effects of education against chronic and delayed onset PTSD was significant for Whites only when other factors were controlled for in regression analyses. For Asians, not only was higher education not protective against chronic PTSD, having a college degree or graduate training was associated with slightly greater odds of chronic PTSD, although this did not reach statistical significance. Racial difference was marginally significant in the association between education and odds of chronic PTSD after adjusting for multiple testing.

The general lack of a protective effect of education for Asians reflects previous findings and may indicate that the educational attainment of many immigrants was not positively correlated with their occupational accomplishments because their qualifications were not recognized in their host country (Zeng & Xie, 2004) and these individuals may be less able to access mainstream resources through the social capital that comes with higher education. Being an *immigrant* was associated with greater odds of poorer PTSD patterns among Asians and Whites, potentially due to compromised access to resources, opportunities, and support (Derr, 2016).

Higher household *income*, especially reporting a yearly income of ≥$100,000, was a significant protective factor for both odds of the chronic and the delayed onset PTSD for both races. In general, the lower odds associated with higher income appeared somewhat greater for Asians than Whites across PTSD groups, although this difference did not reach statistical significance. It is possible that monetary resources were more beneficial among more deprived groups by alleviating stress that could cause or reinforce mental health issues. However, *employment* was not significantly associated with PTSD group for Asians, although it reduced the odds of chronic PTSD by 45% for Whites. The result, while counterintuitive, echoed our previous Wave 1 finding and could be explained partly by the underemployment or low-wage manual work of Asians in restaurants or service industries, as reflected in a high proportion earning annual income of < $50,000.

Another work-related factor, although also exposure-related, was *job loss due to 9/11*, which significantly increased the odds of both chronic and delayed onset groups for both races. Such job loss among the economically deprived Asians may have undermined coping resources, particularly for those who also experienced the lasting economic devastation in the Chinatown area (Asian American Federation, 2008). Additionally, a high percentage of Whites were rescue and recovery workers, who were found to have a greater tendency to experience premature exit from the labor force in later years through early retirement or chronic health conditions, especially those with PTSD comorbidity (Niles et al., 2011; Yu, Brackbill, Locke, Stellman, & Gargano, 2016).

The impact of *marital status* in general showed a different pattern between races across PTSD status groups, although this difference did not reach statistical significance. For Asians, in both chronic and the delayed onset groups, never married was a protective category; and for Whites, divorced/widowed/separated was a risk category relative to married/cohabiting. The cultural norm of Asians for unmarried adult children is to live with their families of origin (Logan & Bian, 2004) and this may provide more social and economic support. Western culture, which subscribes greater importance to the marital relationship and independence among unmarried adults (Billari & Liefbroer, 2016), may provide less protection for being never married but greater harm associated with the dissolution of marriage among Whites.

The level of *direct disaster exposure* elevated the odds of poorer PTSD status over time to the greatest extent among all factors for both races, consistent with previous findings (Pietrzak et al., 2014), highly affecting the odds of chronic PTSD. Exposure to imminent danger such as being in a collapsed/damaged building or dust cloud or having witnessed horrific events could be very traumatizing with lasting effects. *Losing someone and tangible loss in 9/11* also elevated the odds of both chronic PTSD and delayed onset for both races, with no racial difference detected.

Having *LRS* also emerged as a factor strongly associated with higher odds of poor PTSD status for both races, particularly for chronic PTSD. The association between LRS and PTSD was found to be strong in both races in our previous study and as reported in other studies (Shiratori & Samuelson, 2012). It has been suggested that the two disorders had a mutually reinforcing nature that resulted in an intensification of both illnesses (Friedman et al., 2013).

Pre-9/11 mental health diagnosis, including depression or anxiety disorder, significantly increased the odds of chronic and delayed onset PTSD, with significantly higher odds of delayed onset PTSD among Asians compared to Whites, even

after multiple testing adjustment; this was the only significant racial difference detected in this study. This finding may indicate a more vulnerable initial mental health status among Asians, who had a pre-9/11 mental disorder diagnosis compared to Whites, who also had such a condition. Having a prior mental disorder diagnosis may indicate more severe symptoms among Asians, which forced them to reach out for services, even as this group has a low tendency to seek mental health help (U.S. Department of Health and Human Services, 2001).

To summarize, exposure-related variables, especially direct disaster exposure, greatly elevated the odds of poorer PTSD outcome for both Asians and Whites, but the effects seem to be universal, with no racial difference. Comorbid LRS and prior mental health diagnosis also considerably increased individuals' vulnerability for poorer PTSD patterns for both races. The effects of socioeconomic status seemed to put Asians in a more disadvantaged position. Although higher socioeconomic status was generally associated with the resilient group and lower socioeconomic status with poorer PTSD outcomes, race modulates the effect such that some protective factors such as education and employment benefited Whites but did not confer protection for Asians. The higher proportion of Asians being immigrants and having lower socioeconomic status was overall associated with significantly less desirable PTSD outcomes 5–6 years after the 9/11 attack.

3.1 | Strengths and limitations

This study, to our knowledge, was the single largest investigation of short- to medium-term PTSD patterns over time and the factors associated with these patterns among Asian Americans directly affected by the WTC attack. Moreover, the comprehensive recruitment and follow-up efforts of the Registry, including the use of Asian-language interviewers to include less acculturated respondents and an outreach effort to those not responding through mail or Internet surveys to lower dropout rates, all helped to reduce bias. The longitudinal nature of the study also allowed for examination of factors associated with PTSD status over time and reduced the potential for temporal ambiguity.

Despite these strengths, several limitations should be considered when interpreting results from this study. We were not able to capture the diversity in ethnicity within the Asian participant group because such data were not collected. It is possible that there were differences in PTSD status and the factors associated with PTSD status after 9/11 between specific Asian American subgroups. The only proxy available to identify the ethnic groups was the language interviewed, which had its flaws because it captured only the non-English-speaking subgroups. We found that 504 Asian participants (20.74%) were interviewed in Chinese (Cantonese and Mandarin), and only 10 (0.41%) were interviewed in other Asian languages, which were grouped together in the dataset due to the small number of respondents in each language.

The non-English-speaking Chinese participants differed significantly (p < 0.01) from the rest of the Asian group in PTSD status, with lower proportions in the resilient and chronic group (74.40% vs. 78.80% and 6.40% vs. 8.07%, respectively) but higher proportions in the delayed onset and remitted group (12.80% vs. 7.57% and 6.4% vs. 5.56%, respectively). These Chinese were also less educated (16.87% vs. 72.05% having college or higher degree, p < 0.001) and had a higher proportion being immigrants (65.28% vs. 46.04%, p < 0.001) compared to the rest of the Asian group. However, they did not differ in the proportion of pre-9/11 depression or anxiety disorder from the rest of the Asian group. Future studies that investigate this potential heterogeneity would be useful for better understanding the experience of the diverse and growing Asian American population.

PTSD was assessed using a self-reported screening instrument, which cannot indicate clinical diagnosis. However, the instrument used has been validated in many populations including Asian Americans (Whealin et al., 2013). Further, while most of the disaster exposure related variables were assessed 2–3 years after the attack, a few were measured 5–6 years afterwards. This along with the self-reported nature of the questions potentially introduced recall bias and underreporting of disaster exposure (Farfel et al., 2008). Finally, the relatively smaller sample size among Asians compared to Whites may have resulted in a lower power to detect statistically significant associations among Asian participants.

3.2 | Implications for future research

A sizeable group of Asian Americans in the chronic and delayed onset groups still suffered from probable PTSD 5–6 years after the WTC attack, signifying the persistent effects of an event that resulted in substantial human suffering and socioeconomic costs. The more disadvantaged socioeconomic status among Asians may have rendered them more vulnerable in their mental health status over time relative to the non-Hispanic White group. Together with Asians' well documented lower tendency to seek mental health treatment (Abe-Kim et al., 2007), outreach efforts to Asians are needed to ensure follow-up treatment and prevention. Because nearly 10% of Asians had a delayed onset of PTSD between 3 and 6 years between the two waves, outreach should also target individuals with elevated PTSD symptoms even if they do not reach the clinical threshold.

Our study findings suggest ways to identify and target higher risk Asian subgroups for treatment and prevention, particularly those with high direct disaster exposure and those with LRS. In addition to those with pre-9/11 PTSD diagnosis, individuals with previous depression or other anxiety disorder diagnosis should also be attended to in prevention and outreach efforts. Given the tendency of Asians to not acknowledge psychological distress but instead seek help for physical ailments (Kung & Lu, 2008), an effective "bridge" between medical and psychiatric services whereby both services are available on one site could help to reduce the stigma in mental health service use (Chen, Kramer, & Chen, 2003). This is especially pertinent given the high comorbidity and possible mutual reinforcement of LRS and PTSD. Routine inquiry about their previous disaster exposure and current and previous psychological functioning in primary care settings would be of great help.

Asian Americans with very low household income should also be targeted for intervention. Level of employment and earned income should be explored beyond employment status. Attention should also be paid to immigrants because such status significantly elevated odds of poorer PTSD patterns. Outreach efforts such as the Registry's Treatment Referral Program should be continued and staffed with bilingual personnel because the majority of Asians are immigrants and many have limited English proficiency (United States Census Bureau, 2014). Additional bilingual services are critical to engage this population in treatment.

3.3 | Conclusion

At 5-6 years after the WTC attack, 17.7% Asian Americans directly exposed to the disaster still had diagnosable PTSD, and close to 10% had delayed onset not detected at 2-3 years, indicating the importance of early outreach and follow-up treatment for this group which has a pattern of underutilization of mental health service. A significant though small difference in short- to medium-term PTSD status change was noted between the Asian and White groups with Asians having a lower proportion in the resilient group and a higher proportion in the chronic group. Generally, advantaged socioeconomic status was associated with resilience and disadvantaged status with chronic and delayed onset of PTSD, which put Asians at higher vulnerability due to their overall lower socioeconomic status. Moreover, some supposedly favorable factors such as education and employment status did not confer protection for Asians against poor mental health outcome. The study findings suggested targeting higher risk Asian subgroups for treatment and prevention, including those with high direct exposure, Lower Respiratory Symptoms, pre-disaster mental disorders, and low household income.

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