The Burden of Subthreshold Posttraumatic Stress Disorder in World Trade Center Responders in the Second Decade After 9/11

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ABSTRACT

Objective: To characterize the prevalence, risk and protective correlates, and clinical characteristics associated with probable subthreshold posttraumatic stress disorder (PTSD) in police and nontraditional (eg, construction workers) World Trade Center (WTC) responders a median of 12.2 years after September 11, 2001.

Methods: A total of 4,196 WTC responders, monitored via the WTC Health Program, completed a web-based survey between 2012 and 2014 assessing a range of variables, including demographics, WTC exposures, medical and psychiatric comorbidities, and mental health services use. The sample included 2,029 police responders and 2,167 nontraditional responders. Current (past-month) probable WTC-related PTSD level (none, subthreshold, or full PTSD) was assessed based on *DSM-IV* criteria using the PTSD Checklist-Specific Stressor version (PCL-S).

Results: The prevalence of current probable full and subthreshold WTC-related PTSD in police responders was 9.3% and 17.5%, respectively, and in nontraditional responders was 21.9% and 24.1%, respectively. Risk and protective correlates for subthreshold PTSD included post-9/11 medical comorbidities and traumatic events (odds ratios [ORs] = 1.1–1.2). Clinical characteristics included elevated rates of comorbid depression (OR = 3.2 and 3.9 for subthreshold PTSD and 17.2 and 30.3 for full PTSD for nontraditional and police responders, respectively). Among responders with subthreshold PTSD, police were more likely to have accessed mental health services and utilized a greater variety of treatments than nontraditional responders.

Conclusions: Overall, 26.8% of police and 46.0% of nontraditional responders met criteria for probable WTC-related full or subthreshold PTSD an average of 12 years after 9/11. Probable subthreshold PTSD, which is not typically assessed in clinical settings, was more prevalent than probable full PTSD and was associated with significantly elevated rates of psychiatric comorbidities, functional impairment, and reduced quality of life. These findings underscore the importance of assessing, monitoring, and possibly treating subthreshold PTSD in WTC and other disaster responders.

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Following trauma exposure, a considerable proportion of individuals are at risk of developing posttraumatic stress disorder (PTSD). An equal or greater proportion may develop subthreshold PTSD, also called subsyndromal or partial PTSD,[1,2] defined as the presence of substantial PTSD symptoms but falling short of criteria for full PTSD diagnosis.[3] Subthreshold PTSD is chronic and disabling, with a US lifetime prevalence of 6.6% (versus 6.4% for full PTSD), mean episode duration of nearly 10 years,[2] and elevated rates of psychiatric comorbidities and functional impairment.[4–6] Initial subthreshold PTSD following trauma exposure may also confer increased risk of subsequently developing delayed-onset PTSD,[4,7] underscoring the importance of prevention and treatment for trauma survivors with subthreshold PTSD.

Among September 11, 2001, World Trade Center (WTC) responders, subthreshold PTSD may be more prevalent than full PTSD.[8] However, only a few studies have examined sociodemographic, trauma-related, and clinical characteristics associated with WTC-related subthreshold PTSD. Of these studies, one[8] reported an intermediate level of functional impairment, psychiatric comorbidity, and perceived need for mental health care among a sample of police WTC responders with probable subthreshold PTSD approximately 4 years after 9/11 compared to police with probable full PTSD and no PTSD. Another study[4] examining a sample of responders 1–5 years after 9/11 found a similarly graded pattern of functional impairment among responders with subthreshold PTSD. These studies suggest that, in WTC responders, subthreshold PTSD is

Clinical Points

- Patients often report subthreshold posttraumatic stress disorder (PTSD) symptoms that fall short of *DSM* criteria for PTSD; the clinical significance of these symptoms deserves further study.
- Functional impairment and comorbid alcohol use problems and depressive symptoms may be considerable in patients who present with subthreshold PTSD symptoms, though attenuated compared to those in patients with probable full PTSD.

associated with an intermediate level of symptom severity and functional impairment compared to full PTSD. Despite these key findings, no studies have examined the prevalence of current subthreshold PTSD in WTC responders and associated risk and protective correlates and clinical characteristics over a decade after 9/11. A clearer picture of WTC-related subthreshold PTSD in the second decade after 9/11 is critical to understand the significance of this chronic and impairing condition and to inform ongoing monitoring and treatment efforts.

This study had 3 aims: (1) to characterize the prevalence of current probable subthreshold and full WTC-related PTSD in responders an average of 12 years after 9/11, (2) to identify risk and protective correlates independently associated with current subthreshold and full PTSD, and (3) to examine the relationship between current subthreshold and full PTSD and other clinical characteristics. Risk and protective correlates and clinical characteristics were chosen based on previously described associations with full PTSD in WTC responders and include sociodemographic variables, WTC-related traumatic exposures, social support during WTC recovery work, post-9/11 traumatic and stressful life events,[9] and mental health service use. Based on prior research,[4,8] we hypothesized the following:

1. The prevalence of probable subthreshold PTSD would be equal to or greater than the prevalence of probable full PTSD.
2. Hispanic ethnicity, female sex, pre-9/11 psychiatric comorbidities, social support during WTC recovery work, and post-9/11 factors including medical comorbidities and additional stressful and traumatic life events after 9/11 would be linked with progressively greater odds of current and probable subthreshold and full PTSD.
3. There would be a "dose-response" relationship between probable full and subthreshold PTSD and clinical characteristics, with full PTSD and subthreshold PTSD associated with high and intermediate elevated rates of psychiatric comorbidities and functional impairment, respectively, relative to trauma-exposed responders without full or subthreshold PTSD.

METHOD

Participants

In 2002, the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health established the WTC Medical Monitoring and Treatment Program, which later became the WTC Health Program (WTC-HP). The WTC-HP provides both health monitoring and treatment to responders in the greater New York City area and nationwide. To be eligible, responders must have worked in Manhattan south of Canal Street, on the barge-loading piers in Manhattan, or at the Staten Island landfill for at least 24 hours during September 11–30, 2001, or for over 80 hours between September 11 and December 31, 2001. Responders who worked in the Pennsylvania or Washington, DC, recovery efforts were not eligible. Traditional responders (ie, police) and nontraditional responders (eg, utility workers, asbestos cleaners, construction workers, administrators, volunteers, transportation workers[10]) were among those eligible.

The present study utilized a nested cohort cross-sectional design, analyzing data from a subset of responders who had completed at least 3 WTC-HP monitoring visits as part of a larger, longitudinal study of PTSD symptom trajectories.[11,12] Of 10,835 responders who had completed 3 visits, 6,642 (61.3%) provided consent to be contacted for future studies and were mailed invitation letters between June 2012 and December 2014 to complete a web-based survey (hard-copy and Spanish versions were also offered). To encourage survey completion, reminder e-mails and telephone calls were made. Of 6,642 invitations, 4,487 surveys (67.6%) were submitted.[11] Of the submitted surveys, 291 (6.5%) were excluded due to missing PTSD Checklist Specific-Stressor version (PCL-S) (267, 6.0%) or responder type (eg, police or nontraditional; n = 24, 0.5%) data. Ultimately, 4,196 surveys (response rate: 63.2%) were included in these analyses, comprising 2,029 police and 2,167 nontraditional responders. Median completion time was 12.2 years post-9/11 (range, 11.0–13.4 years). Comparing survey completers versus noncompleters for the 10,835 responders revealed no differences in sex. Completers were older (mean ± SD = 44.3 ± 8.8 vs 43.4 ± 8.8 years, $t_{10,833} = 5.30$ $P < .001$) and more likely to be white (64.3% vs 59.7%, $\chi^2_1 = 23.46$, $P < .001$) and police responders (41.8% vs 34.0%, $\chi^2_1 = 67.08$, $P < .001$). Completers endorsed more WTC traumatic exposures (mean ± SD = 4.3 ± 2.1 vs 4.0 ± 2.1, $t_{10,833} = 6.85$, $P < .001$) and scored lower on their initial monitoring visit PCL-S assessment (mean ± SD = 30.1 ± 13.7 vs 32.7 ± 15.8, $t_{10,732} = 9.08$, $P < .001$).[11]

Dependent Variables

WTC-related PTSD level. The PCL-S[13] is a self-report measure comprising 17 items (score range, 17–85) assessing *DSM-IV* PTSD symptoms occurring over the past month associated with WTC-related exposures (Cronbach α = 0.95 in police responders and 0.96 in nontraditional responders).

Probable full PTSD was operationalized as score ≥ 39[14] and endorsement of 3 *DSM-IV* criteria required for a

diagnosis of PTSD: at least 1 of 5 reexperiencing symptoms (Criterion B); 3 of 7 avoidance/numbing symptoms (Criterion C); and 2 of 5 hyperarousal symptoms (Criterion D). Although a cutoff score of ≥ 44 is used elsewhere in the literature, we chose ≥ 39 in order to be consistent with prior research on WTC-related PTSD.[8] Probable subthreshold PTSD was operationalized as meeting Criterion B and either C or D, or if Criterion B was met and at least 1 symptom from both C and D was endorsed.[1,15] Responders who were exposed to WTC recovery work but did not meet criteria for full or subthreshold PTSD were designated as "trauma controls," consistent with terminology in previous literature.[8]

Clinical characteristics. The following assessments were made in the web-based survey:

- The CAGE questionnaire[16] to screen for current alcohol use problems, with a score ≥ 2 indicative of a possible alcohol use problem.
- The Patient Health Questionnaire-2 (PHQ-2)[17] to screen for current depression symptoms, with a score ≥ 3 indicative of a positive screen for depression. (Cronbach α = 0.89 in nontraditional responders, 0.82 in police).
- The Quality of Life Enjoyment and Satisfaction Questionnaire Short Form (Q-LES-Q-SF), consisting of 14 items assessing overall quality of life as a percent of maximum score (0%–100%).[18,19] (Cronbach α = 0.95 in nontraditional responders, 0.94 in police.)
- The Sheehan Disability Scale (SDS)[20] to assess functional impairment associated with emotional problems in 3 domains: work/school, social, and family/home responsibilities, with scores for each ranging from 0 = not at all to 10 = extremely. We used the sum score of the 3 domains (maximum score = 30) to provide a global assessment of functional impairment. For individuals who indicated they were not currently working (eg, retired), the mean of the social and family/home scores was substituted for the work score.
- Mental health service utilization. Participants indicated whether they had utilized any of 8 types of mental health services after 9/11, including one-on-one psychotherapy, alcohol counseling, medication, marriage and family counseling, peer-support therapy, group therapy, religious counseling, and stress counseling. These 8 types of services were consolidated into 5 based on similarities in treatment types. A dichotomous variable assessing any mental health service use after 9/11 was also derived.

Independent Variables

Independent variables were selected based on prior theoretical models of PTSD risk as described in the Introduction. Variables were assessed both during the initial WTC-HP monitoring visit and on the web-based survey, depending on variable type. For example, WTC exposure severity was assessed at the initial monitoring visit to minimize recall bias, whereas number of post-9/11 traumatic life events was assessed on the web-based survey. As detailed in Table 1 and seen in Table 2, risk and protective correlates assessed included the following:

- Demographic characteristics (age, sex, education level, marital status, race/ethnicity, employment status).
- Variables related to experiences during WTC recovery work: number of WTC-related traumatic exposures, number of sources of family support, presence of work support, stressful life events since 9/11 assessed at the initial monitoring visit,[21] perceived preparedness for WTC recovery work,[22] prior classes or exercises in disaster response, and participation in prior rescue/recovery efforts.
- Additional life stressors after 9/11 assessed on the web-based survey: number of additional stressful life events, number of medical conditions,[23] and number of traumatic events since 9/11.[24]

Data Analysis

Missing survey values were multiply imputed using chained equations, with multinomial logistic, logistic, or ordinary least squares regression models, as appropriate to outcome variable type. There were 100 imputed data sets. The full multiple imputation code is provided in Supplementary Appendix 1. Because of differences in disaster preparedness and rates of psychopathology in police versus nontraditional responders,[25,26] analyses were conducted separately in these two groups.

To examine the relationship between risk and protective correlates and WTC-related PTSD level, multinomial logistic regression analyses were conducted. With police and nontraditional responder samples analyzed separately, risk and protective correlates (see Table 1) were entered as predictor variables, whereas PTSD level was designated as the outcome variable (reference category: trauma controls).

To examine how clinical characteristics varied based on PTSD level, multinomial logistic regressions and analyses of covariance were conducted. In these analyses, PTSD level was the predictor variable, whereas clinical characteristics (ie, alcohol use problems, positive depression screen, SDS score, quality of life, and mental health treatment) were designated as outcome variables. Analyses were adjusted for all risk and protective correlates shown in Table 1.

RESULTS

PTSD Prevalence

In police responders, prevalence of past-month probable subthreshold PTSD was 17.5%, and prevalence of full PTSD was 9.3%. In nontraditional responders, prevalence of subthreshold PTSD was 24.1%, and prevalence of full PTSD was 21.9%. The remaining responders did not meet criteria for probable subthreshold or full PTSD and were designated as trauma controls.

Table 1. Risk and Protective Correlates Assessed at the First WTC Monitoring Visit and With the Web-Based Survey

Variable	Description
Assessed at the First WTC Monitoring Visit[11]	
Sociodemographic characteristics	Sex, education (high school or less, more than high school)
Pre-9/11 psychiatric diagnoses	Diagnosis of anxiety disorder, depression, or PTSD by a health professional before 9/11/2001; dichotomous variable based on participant report.
WTC exposure severity	Count of 10 WTC-related exposures: (1) arrived at the WTC site between 9/11/2001 and 9/13/2001; (2) worked primarily at/adjacent to the collapse site known as the "pit" or the "pile" during September 2001; (3) participated in search and rescue; (4) worked longer than the median number of hours at the WTC site; (5) exposed to human remains; (6) was caught in the dust cloud; (7) slept at the site; (8) experienced death of a colleague, friend, or family member on 9/11; (9) received treatment for an illness or injury during WTC-recovery work; and (10) knows someone who suffered an injury on 9/11.[12]
No. of life stressors since 9/11	Two separate counts of the same 15 life stressors from the Disaster Supplement of the Diagnostic Interview Schedule,[21] eg, "lost a job/laid off/lost income," "divorced from spouse," "had debt trouble," "serious illness/injury."
WTC-related social support	Number of important sources of family support (count range, 0–5 [spouse, partner, children, parent(s), other family]) and work support (dichotomized [supervisor and/or coworkers] vs none) while working for the WTC recovery effort.
Assessed With the Web-Based Survey	
Sociodemographic characteristics	Age (continuous), race/ethnicity (white, non-Hispanic; black, non-Hispanic; Hispanic/Latino; other), work status (working full- or part-time, disabled/unemployed/student/other, and retired), marital status (never married, married/partnered, widowed/separated/divorced).
Prior classes or exercises in rescue and recovery	Received prior classes or exercises in rescue work (dichotomous): "Prior to 9/11/2001, did you ever take part in any of the following, intended to prepare you to participate in rescue and recovery efforts after an accident or a disaster? (1) attended one or more classes or sessions, (2) participated in one or more simulation exercises or drills."
No. of rescue/recovery occasions before 9/11	Count of rescue and recovery occasions (range, 0–5 or more) the responder participated in prior to 9/11: "Prior to 9/11/2001, did you ever take part in any rescue and recovery efforts after an accident or a disaster? If yes, on how many different occasions?"
Perceived preparedness	Count of affirmative responses to 4 items (range, 0–4), modified from the Deployment Risk and Resilience Inventory[22]: "Below are statements of how well prepared you were for your 9/11-related rescue and recovery efforts. Please circle the response that describes you best: (1) 'My work and activities before 9/11 provided me with helpful training to perform my 9/11-related recovery work.' (2) 'On site, I was adequately informed about the role I was expected to play.' (3) 'When I was performing my 9/11-related work, I had a good idea of how long my work would take to complete.' (4) 'I was adequately trained to perform the tasks required of me during the recovery efforts.'"
No. of medical conditions after 9/11	Count of medical conditions diagnosed by a health care professional after 9/11, participant-reported: checklist from the National Epidemiologic Survey on Alcohol and Related Conditions Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV[23] with additional WTC-related conditions added (asthma or chronic respiratory condition, chronic rhinitis or sinusitis, sleep apnea, gastroesophageal reflux disease, or acid reflux).
No. of traumatic events before and after 9/11	Two separate counts of the same 14 potentially traumatic events in the Trauma History Screen[24] (eg, really bad accident, natural disaster, forced sexual contact, attacked with a gun/knife/weapon) plus a 15th one, "life-threatening illness or injury."
No. of additional life stressors after 9/11	Count of 3 stressors since 9/11: "lost my job," "gone through a divorce or been left by a partner or significant other," "had problems getting access to adequate healthcare." Specific life stressors endorsed at both the first monitoring visit and the web-based survey were counted only at the first monitoring visit.

Abbreviations: PTSD = posttraumatic stress disorder, WTC = World Trade Center.

Descriptive Statistics

Table 2 (3 leftmost columns) shows descriptive statistics of police and nontraditional responders with no PTSD (trauma controls), subthreshold PTSD, and full PTSD. At the time of the survey, mean age of police and nontraditional responders was 50.8 and 55.6 years, respectively. Overall, responders were predominantly of white race, male sex, above high school education, and married. (See Table 2 for additional descriptive statistics.)

Risk and Protective Correlates

Table 2 (3 rightmost columns) shows the results of multinomial logistic regression analyses examining the relationship between risk and protective correlates and PTSD level. In police responders, variables associated with subthreshold and full PTSD included female sex (OR = 1.7 and 2.0, respectively), self-reported psychiatric diagnosis prior to 9/11 (of depression, anxiety, and/or PTSD) (OR = 1.8 and 2.3), number of post-9/11 medical conditions (OR = 1.2 and 1.3), and number of post-9/11 traumatic experiences (OR = 1.1 and 1.3). Disability or unemployment was associated with full PTSD only (OR = 2.8). Greater perceived preparedness was associated with lower odds of both subthreshold and full PTSD (OR = 0.8 and 0.7, respectively).

In nontraditional responders, variables associated with both subthreshold and full PTSD included black race (OR = 1.8 and 1.7, respectively), Hispanic ethnicity (OR = 2.0 and 2.5), number of post-9/11 traumatic experiences (OR = 1.2 and 1.2), and number of post-9/11 medical conditions (OR = 1.2 and 1.3). Variables associated with full PTSD but not subthreshold PTSD include current unemployment (OR = 2.3), self-reported psychiatric

Table 2. Risk and Protective Correlates and PTSD Level for Police Responders (n = 2,029) and Nontraditional Responders (n = 2,167)[a,b]

Variable	Descriptive Statistics			Multinomial Logistic Regression		
	Trauma Controls	Subthreshold PTSD	Full PTSD	Subthreshold PTSD vs Trauma Controls, aOR (95% CI)	Full PTSD vs Trauma Controls, aOR (95% CI)	Full PTSD vs Subthreshold PTSD, aOR (95% CI)
Police Responders, n (%)	1,485 (73.2)	355 (17.5)	189 (9.3)			
Age at time of survey, mean (SD), y	50.4 (7.1)	51.9 (7.3)	52.0 (7.8)	1.0 (1.0–1.1)	1.0 (1.0–1.1)	1.0 (1.0–1.0)
Sex, n (%)						
Male (reference)	1,298 (87.4)	296 (83.4)	148 (78.3)	…	…	…
Female	187 (12.6)	59 (16.6)	41 (21.7)	**1.7 (1.1–2.4)**	**2.0 (1.2–3.3)**	1.2 (0.7–2.0)
Race/ethnicity, n (%)						
White, non-Hispanic (reference)	978 (67.2)	238 (69.0)	127 (69.0)	…	…	…
Black, non-Hispanic	152 (10.4)	26 (7.5)	11 (6.0)	0.8 (0.5–1.3)	0.6 (0.3–1.2)	0.7 (0.3–1.6)
Hispanic/Latino	248 (17.0)	66 (19.1)	39 (21.2)	1.2 (0.8–1.6)	1.2 (0.8–1.9)	1.0 (0.6–1.7)
Other	78 (5.4)	15 (4.4)	7 (3.8)	1.0 (0.5–2.2)	0.3 (0.1–1.6)	0.3 (0.1–1.6)
Education, n (%)						
High school or less (reference)	237 (16.0)	66 (18.6)	28 (14.8)	…	…	…
More than high school	1,248 (84.0)	289 (81.4)	161 (85.2)	0.8 (0.6–1.1)	1.2 (0.7–2.0)	1.5 (0.9–2.5)
Marital status, n (%)						
Never married (reference)	209 (14.1)	45 (12.7)	26 (13.8)	…	…	…
Married or partnered	1,087 (73.2)	260 (73.2)	131 (69.3)	0.9 (0.6–1.3)	0.8 (0.4–1.4)	0.9 (0.5–1.6)
Widowed, separated, or divorced	189 (12.7)	50 (14.1)	32 (16.9)	0.7 (0.4–1.1)	0.5 (0.3–1.0)	0.8 (0.4–1.7)
Work status, n (%)						
Working, full or part time (reference)	1,030 (69.4)	210 (59.2)	76 (40.2)	…	…	…
Disabled, unemployed, or student	112 (7.5)	50 (14.1)	68 (36.0)	1.1 (0.7–1.6)	**2.8 (1.8–4.4)**	**2.6 (1.6–4.3)**
Retired	313 (21.1)	85 (24.0)	37 (19.6)	1.0 (0.7–1.4)	1.1 (0.6–1.8)	1.0 (0.4–1.7)
Pre-9/11 variables						
Diagnosis of depression, anxiety disorder, and/or PTSD prior to 9/11, n (%)	78 (5.3)	43 (12.1)	39 (20.6)	**1.8 (1.2–2.8)**	**2.3 (1.3–3.9)**	1.3 (0.7–2.2)
No. of life stressors in year before 9/11, mean (SD)	1.0 (1.5)	1.2 (1.0)	1.5 (2.1)	1.0 (0.9–1.1)	1.0 (0.9–1.1)	1.0 (0.9–1.2)
No. of traumatic events before 9/11, mean (SD)	2.8 (2.3)	3.7 (2.6)	4.3 (3.0)	1.1 (1.0–1.1)	1.1 (1.0–1.2)	1.0 (0.9–1.1)
9/11 preparedness						
Received classes/exercises in rescue/recovery before 9/11, n (%)	844 (56.8)	219 (61.7)	103 (54.5)	1.2 (0.9–1.7)	1.0 (0.7–1.6)	0.9 (0.5–1.4)
No. of rescue/recovery occasions before 9/11 (range, 0–5), mean (SD)	2.0 (2.1)	2.4 (2.2)	2.3 (2.1)	1.0 (1.0–1.1)	1.0 (0.9–1.1)	1.0 (0.9–1.1)
Perceived preparedness (range, 0–4), mean (SD)	1.8 (1.5)	1.4 (1.3)	1.1 (1.2)	**0.8 (0.7–0.9)**	**0.7 (0.6–0.8)**	0.9 (0.7–1.0)
9/11 and Post-9/11 variables						
WTC exposure severity (range, 0–10), mean (SD)	5.0 (2.0)	5.5 (1.9)	5.5 (2.1)	1.1 (1.0–1.2)	1.1 (1.0–1.2)	1.0 (0.9–1.1)
No. of important sources of family support while working for the WTC recovery effort, mean (SD)	2.7 (1.7)	2.6 (1.6)	2.7 (1.7)	1.0 (0.9–1.1)	1.0 (0.8–1.1)	1.0 (0.9–1.1)
≥ 1 Important source of work support while working for the WTC recovery effort, n (%)	873 (58.8)	194 (54.7)	106 (56.1)	0.8 (0.6–1.1)	0.9 (0.6–1.4)	1.2 (0.8–1.9)
No. of medical conditions after 9/11, mean (SD)	3.6 (2.4)	5.0 (2.6)	6.3 (2.6)	**1.2 (1.1–1.2)**	**1.3 (1.2–1.4)**	1.1 (1.0–1.2)
No. of life stressors since 9/11, mean (SD)	2.0 (1.9)	2.6 (2.2)	3.4 (2.5)	1.1 (1.0–1.2)	1.1 (1.0–1.2)	1.0 (0.9–1.1)
No. of traumatic events after 9/11, mean (SD)	2.7 (1.9)	3.8 (2.2)	4.8 (2.5)	**1.1 (1.1–1.2)**	**1.3 (1.2–1.4)**	1.2 (1.0–1.3)
No. of additional life stressors after 9/11 (range, 0–3), mean (SD)	0.2 (0.4)	0.3 (0.5)	0.5 (0.7)	1.3 (1.0–1.6)	**1.6 (1.3–2.2)**	1.3 (1.0–1.8)

(continued)

Table 2 (continued).

Variable	Descriptive Statistics			Multinomial Logistic Regression		
	Trauma Controls	Subthreshold PTSD	Full PTSD	Subthreshold PTSD vs Trauma Controls, aOR (95% CI)	Full PTSD vs Trauma Controls, aOR (95% CI)	Full PTSD vs Subthreshold PTSD, aOR (95% CI)
Nontraditional Responders, n (%)	1,170 (53.99)	522 (24.09)	475 (21.92)			
Age at time of survey, mean (SD), y	55.7 (10.0)	56.4 (9.1)	54.5 (8.3)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	1.0 (1.0–1.0)
Sex, n (%)						
Male (reference)	1,038 (88.7)	455 (87.2)	379 (79.8)	…	…	…
Female	132 (11.3)	67 (12.8)	96 (20.2)	1.2 (0.8–1.7)	1.3 (0.9–2.0)	1.2 (0.8–1.8)
Race/ethnicity, n (%)						
White, non-Hispanic (reference)	823 (72.5)	309 (61.2)	235 (50.2)	…	…	…
Black, non-Hispanic	108 (9.5)	62 (12.3)	47 (10.0)	**1.8 (1.3–2.7)**	**1.7 (1.1–2.8)**	0.9 (0.6–1.5)
Hispanic/Latino	137 (12.1)	103 (20.4)	152 (32.5)	**2.0 (1.4–2.7)**	**2.5 (1.7–3.6)**	1.3 (0.9–1.8)
Other	68 (6.0)	31 (6.1)	34 (7.3)	1.3 (0.7–2.3)	1.5 (0.8–2.9)	1.2 (0.6–2.3)
Education, n (%)						
High school or less (reference)	388 (33.2)	190 (36.4)	188 (39.6)	…	…	…
More than high school	782 (66.8)	332 (63.6)	287 (60.4)	0.8 (0.7–1.1)	0.8 (0.6–1.1)	1.0 (0.7–1.3)
Marital status, n (%)						
Never married (reference)	188 (16.1)	77 (14.8)	70 (14.7)	…	…	…
Married or partnered	848 (72.5)	365 (69.9)	289 (60.8)	1.0 (0.7–1.4)	1.4 (0.9–2.2)	1.5 (0.9–2.3)
Widowed, separated, or divorced	134 (11.5)	80 (15.3)	116 (24.4)	1.0 (0.6–1.5)	1.6 (1.0–2.7)	1.7 (1.0–2.8)
Work status, n (%)						
Working, full or part time (reference)	793 (67.8)	312 (59.8)	204 (43.0)	…	…	…
Disabled, unemployed, or student	114 (9.7)	82 (15.7)	196 (41.3)	1.1 (0.8–1.6)	**2.3 (1.6–3.2)**	**2.0 (1.4–2.9)**
Retired	236 (20.2)	104 (19.9)	40 (8.4)	0.9 (0.6–1.3)	0.8 (0.5–1.2)	0.9 (0.5–1.4)
Pre-9/11 variables						
Diagnosis of depression, anxiety disorder, and/or PTSD prior to 9/11, n (%)	126 (10.8)	78 (14.9)	134 (28.2)	1.3 (0.9–1.8)	**2.3 (1.6–3.2)**	**1.8 (1.3–2.6)**
No. of life stressors in year before 9/11, mean (SD)	1.4 (2.1)	1.6 (2.4)	2.1 (2.8)	1.0 (0.9–1.0)	1.0 (0.9–1.0)	1.0 (0.9–1.0)
No. of traumatic events before 9/11, mean (SD)	2.4 (2.3)	3.1 (2.7)	3.1 (3.0)	1.1 (1.0–1.1)	1.0 (1.0–1.1)	1.0 (0.9–1.0)
9/11 Preparedness						
Received classes/exercises in rescue/recovery before 9/11, n (%)	373 (31.9)	178 (34.1)	151 (31.8)	1.1 (0.8–1.5)	1.1 (0.8–1.5)	1.0 (0.7–1.4)
No. of rescue/recovery occasions before 9/11 (range, 0–5), mean (SD)	1.0 (1.8)	1.1 (1.8)	1.0 (1.7)	0.9 (0.9–1.0)	0.9 (0.9–1.0)	1.0 (0.9–1.1)
Perceived preparedness (range, 0–4), mean (SD)	2.2 (1.4)	1.9 (1.4)	1.4 (1.4)	**0.9 (0.8–0.9)**	**0.7 (0.6–0.8)**	**0.8 (0.7–0.9)**
9/11 and Post-9/11 variables						
WTC exposure severity (range, 0–10), mean (SD)	3.3 (1.7)	3.7 (1.9)	3.7 (2.1)	1.1 (1.0–1.2)	1.1 (1.0–1.2)	1.0 (1.0–1.1)
No. of important sources of family support while working for the WTC recovery effort, mean (SD)	2.2 (1.6)	2.2 (1.7)	1.8 (1.7)	1.0 (0.9–1.1)	0.9 (0.8–1.0)	0.9 (0.9–1.0)
≥ 1 Important source of work support while working for the WTC recovery effort, n (%)	552 (47.2)	255 (48.9)	177 (37.3)	1.14 (0.9–1.5)	1.0 (0.7–1.4)	0.9 (0.6–1.2)
No. of medical conditions after 9/11, mean (SD)	3.8 (2.6)	5.3 (2.7)	6.7 (2.8)	**1.2 (1.1–1.2)**	**1.3 (1.2–1.4)**	**1.1 (1.1–1.2)**
No. of life stressors since 9/11, mean (SD)	2.2 (2.2)	2.6 (2.4)	3.8 (2.9)	1.0 (0.9–1.1)	1.1 (1.0–1.1)	1.1 (1.0–1.1)
No. of traumatic events after 9/11, mean (SD)	2.2 (1.8)	3.1 (2.1)	3.9 (2.5)	**1.2 (1.1–1.2)**	**1.2 (1.2–1.3)**	1.1 (1.0–1.2)
No. of additional life stressors after 9/11 (range, 0–3), mean (SD)	0.3 (0.6)	0.5 (0.7)	0.9 (0.9)	1.2 (1.0–1.4)	**1.5 (1.3–1.8)**	**1.3 (1.1–1.5)**

[a]In the leftmost 3 columns, unadjusted descriptive statistics of risk and protective correlates are shown. In the rightmost 3 columns, results of a multinomial logistic regression analysis are shown as adjusted odds ratios (aORs) with 95% CIs in parentheses. All variables shown in the first column were entered as independent or predictor variables, and PTSD severity (none, subthreshold, full) was designated as the outcome or dependent variable.
[b]Statistically significant aORs and 95% CIs are shown in bold.
Abbreviation: PTSD = posttraumatic stress disorder.

diagnosis prior to 9/11 (of depression, anxiety, and/or PTSD; OR = 2.3), and number of additional post-9/11 life stressors (OR = 1.5). Greater perceived preparedness (OR = 0.9 and 0.7, respectively) was associated with lower odds of both subthreshold and full PTSD.

Psychiatric Comorbidities and Quality of Life

In police (Table 3), increasing PTSD severity was associated with progressively greater odds of a positive depression screen (OR = 3.9 and 30.3 for subthreshold and full PTSD, respectively), greater functional impairment on the Sheehan Disability Scale (mean score differences of 3.0 and 11.8), and lower Q-LES-Q-SF score (mean score differences of −7.4 and −16.8). Similarly, in nontraditional responders (Table 3), both current subthreshold and full PTSD were associated with greater odds of positive depression screen (OR = 3.2 and 17.2 in subthreshold and full groups, respectively), greater odds of positive alcohol use problem screen (OR = 1.6 and 2.2), greater functional impairment (mean score differences of 4.2 and 10.5), and lower Q-LES-Q-SF score (mean score differences of −7.7 and −19.4).

In both responder groups, current subthreshold and full PTSD were associated with increased odds of mental health treatment utilization after 9/11 (OR = 2.1 and 4.5, respectively, in police and 1.4 and 3.9, respectively, in nontraditional responders), with responders with full PTSD being more likely than those with subthreshold PTSD to have utilized treatment. Regarding types of services, in police, current subthreshold PTSD was linked to increased likelihood of having used individual psychotherapy and alcohol counseling, medication, and religious counseling; in nontraditional responders, current subthreshold PTSD was associated only with psychotropic medication use. Current full PTSD was associated with use of individual psychotherapy and alcohol counseling, psychotropic medication, and religious/spiritual/stress counseling in both responder groups and with group psychotherapy in nontraditional responders.

DISCUSSION

To our knowledge, this study is the first to examine the prevalence of probable subthreshold PTSD and risk and protective correlates and clinical characteristics associated with probable subthreshold PTSD in WTC responders over 10 years post-9/11. Previous estimates of subthreshold PTSD prevalence in WTC responders have ranged from 8.9%–15.4% 4 years after 9/11[8,27] to 6.3%–9.5% 10–11 years after 9/11.[28] In this sample, prevalence of probable subthreshold and full PTSD was 17.5% and 9.3%, respectively, in police responders and 24.1% and 21.9%, respectively, in nontraditional responders. These findings provide further suggestion that nontraditional responders, who may receive less preparation or training, may be at greater risk for PTSD.[26] In both responder groups, the high prevalence of subthreshold PTSD may be partly explained by individuals who have partially recovered from full PTSD symptoms.[11] Nevertheless, the finding that a substantial proportion of responders screened positive for subthreshold PTSD more than a decade after 9/11 underscores the burden of this disorder in responders. Our findings highlight the importance of assessing, monitoring, and possibly treating subclinical PTSD symptoms in this and other disaster responder populations.

Having experienced subsequent traumatic events or medical conditions after 9/11 was associated with elevated odds of full and subthreshold PTSD relative to the trauma control group in both police and nontraditional responders. Consistent with previous research, these findings suggest that subsequent life stress following 9/11 may contribute to PTSD symptoms, even many years after initial trauma exposure.[9] With regard to medical conditions, our findings suggest that addressing physical illnesses may benefit PTSD treatment in WTC responders. Indeed, it has been proposed that PTSD-related dysregulation of the hypothalamic-pituitary-adrenal axis may lead to development of somatic medical illness via inflammatory changes.[29] Recent findings also suggest that respiratory and sleep disorders, when untreated, may interfere with PTSD treatment and vice versa.[30,31]

This study also found that current subthreshold and full PTSD are both associated with elevated odds of comorbid depression and alcohol use problems, increased functional impairment, and decreased quality of life, consistent with previous reports of substantial psychiatric comorbidity,[32,33] functional impairment,[34] and reduced health-related quality of life in PTSD.[35] A dose-response relationship was also observed for these clinical characteristics, except for alcohol use problems in nontraditional responders. Interestingly, nontraditional responders with subthreshold PTSD did not differ significantly from trauma controls in terms of mental health service utilization. However, police responders in both the full and subthreshold PTSD groups had significant utilization of services compared to trauma controls, which may account for the lower prevalence of PTSD in police. Alternatively, greater service utilization in police may be an artifact of a high PTSD symptom burden that is underreported due to stigma (eg, fears of being viewed as incompetent for professional duties).[36] One study[37] found that WTC-exposed individuals with high mental health service utilization reported more unmet mental health needs and poor mental health days, suggesting utilization may be a marker of psychiatric morbidity. Additionally, our finding that police with subthreshold or full PTSD were more likely to have used religious or spiritual counseling services compared to trauma controls is notable in light of evidence suggesting religion may have a positive, as well as negative, impact on mental health.[38] Overall, limited utilization of mental health services in nontraditional responders with subthreshold PTSD, despite a substantial burden of symptoms, psychiatric comorbidities, and functional impairment, highlights the need for more research on potential barriers to seeking treatment in nontraditional responders with subthreshold PTSD.

This study has several limitations worth noting. First, although we examined longitudinal trajectories of PTSD

Table 3. PTSD Level and Clinical Characteristics for Police Responders and Nontraditional Responders[a,b]

Variable	Trauma Controls	Subthreshold PTSD	Full PTSD	Subthreshold PTSD vs Trauma Controls, aOR or Mean Difference (95% CI)	Full PTSD vs Trauma Controls, aOR or Mean Difference (95% CI)	Full PTSD vs Subthreshold PTSD, aOR or Mean Difference (95% CI)
Police Responders, n	1,485	355	189			
Positive PHQ-2 screen	37 (2.5)	40 (11.4)	107 (57.5)	**3.9 (2.4 to 6.5)**	**30.3 (17.9 to 51.2)**	**7.8 (4.8 to 12.6)**
Positive CAGE screen	62 (4.2)	22 (6.2)	36 (19.1)	1.4 (0.8 to 2.4)	**4.7 (2.7 to 8.2)**	**3.3 (1.8 to 6.1)**
Sheehan Disability Scale, total score, mean (SD)	1.9 (4.1)	5.7 (6.3)	15.9 (7.7)	**3.0 (2.3 to 3.6)**	**11.8 (11.0 to 12.7)**	**8.9 (8.0 to 9.8)**
Q-LES-Q-SF, percent of maximum score, mean (SD)	72.9 (17.9)	61.0 (17.9)	45.7 (19.2)	**−7.4 (−9.3 to −5.6)**	**−16.8 (−19.4 to −14.2)**	**−9.4 (−12.2 to −6.6)**
Mental health service use after 9/11						
None since 9/11 (reference)	1,179 (89.9)	219 (74.5)	70 (49.3)	…	…	…
Have received treatment since 9/11	132 (10.1)	75 (25.5)	72 (50.7)	**2.1 (1.5 to 2.9)**	**4.5 (3.0 to 6.9)**	**2.2 (1.4 to 3.4)**
Mental health services used, if any						
One-on-one psychotherapy/alcohol counseling	99 (7.6)	65 (22.1)	62 (43.7)	**2.4 (1.6 to 3.4)**	**4.5 (2.9 to 7.0)**	**1.9 (1.2 to 3.0)**
Psychotropic medication	63 (4.8)	45 (15.3)	55 (38.7)	**2.2 (1.4 to 3.4)**	**5.3 (3.3 to 8.6)**	**2.4 (1.5 to 3.9)**
Marriage/family counseling	48 (3.7)	21 (7.1)	13 (9.2)	1.3 (0.8 to 2.3)	1.4 (0.7 to 2.7)	1.1 (0.5 to 2.1)
Religious/spiritual/stress counseling	22 (1.7)	19 (6.5)	18 (12.7)	**2.8 (1.5 to 5.1)**	**2.6 (1.3 to 5.3)**	0.9 (0.5 to 1.8)
Peer support/group psychotherapy	19 (1.5)	11 (3.7)	13 (9.2)	1.3 (0.6 to 2.9)	1.1 (0.4 to 2.7)	0.8 (0.3 to 2.1)
Nontraditional Responders, n	1,170	522	475			
Positive PHQ-2 screen	88 (7.6)	121 (23.9)	338 (72.4)	**3.2 (2.3 to 4.4)**	**17.2 (12.1 to 24.3)**	**5.5 (4.0 to 7.5)**
Positive CAGE screen	66 (5.6)	51 (9.8)	61 (12.8)	**1.6 (1.1 to 2.5)**	**2.2 (1.4 to 3.5)**	1.3 (0.9 to 2.1)
Sheehan Disability Scale, total score, mean (SD)	3.7 (6.0)	9.1 (7.4)	17.8 (7.8)	**4.2 (3.5 to 4.9)**	**10.5 (9.6 to 11.3)**	**6.2 (5.3 to 7.1)**
Q-LES-Q-SF, percent of maximum score, mean (SD)	67.6 (20.9)	55.9 (19.3)	36.6 (19.4)	**−7.7 (−9.5 to −5.9)**	**−19.4 (−21.6 to −17.2)**	**−11.7 (−14.0 to −9.4)**
Mental health service use after 9/11						
None since 9/11 (reference)	1,067 (81.1)	389 (68.6)	181 (35.2)	…	…	…
Have received treatment since 9/11	249 (18.9)	178 (31.4)	333 (64.8)	**1.4 (1.1 to 1.9)**	**3.9 (2.8 to 5.3)**	**2.7 (2.0 to 3.8)**
Mental health services used if any						
One-on-one psychotherapy/alcohol counseling	212 (16.1)	151 (26.6)	297 (57.8)	1.3 (1.0 to 1.7)	**3.3 (2.4 to 4.5)**	**2.6 (1.8 to 3.5)**
Psychotropic medication	104 (7.9)	120 (21.2)	232 (45.1)	**2.3 (1.7 to 3.2)**	**4.0 (2.8 to 5.7)**	**1.7 (1.2 to 2.4)**
Marriage/family counseling	66 (5.0)	32 (5.6)	58 (11.3)	0.7 (0.4 to 1.2)	0.9 (0.5 to 1.5)	1.3 (0.7 to 2.2)
Religious/spiritual/stress counseling	52 (4.0)	58 (10.2)	122 (23.7)	1.5 (1.0 to 2.3)	**2.5 (1.6 to 3.8)**	**1.6 (1.1 to 2.5)**
Peer support/group psychotherapy	29 (2.2)	36 (6.4)	78 (15.2)	1.7 (1.0 to 2.9)	**2.4 (1.4 to 4.2)**	1.4 (0.9 to 2.4)

[a]In the leftmost 3 columns, unadjusted descriptive statistics of clinical characteristics are shown; values are reported as n (%) unless otherwise noted. In the rightmost 3 columns, results of multinomial logistic regression analyses (adjusted odds ratios) and analyses of covariance (mean differences) are shown, for which PTSD severity (none, subthreshold, full) was designated as the independent or predictor variable and clinical characteristics were designated as outcome or dependent variables. Odds ratios and mean differences were adjusted for all variables shown in Table 2.

[b]Statistically significant aORs and 95% CIs are shown in bold.

Abbrevations: aOR = adjusted odds ratio, PHQ-2 = Patient Health Questionnaire-2, PTSD = posttraumatic stress disorder, Q-LES-Q-SF = Quality of Life Enjoyment and Satisfaction Questionnaire Short Form.

severity in our prior study,[11] the present cross-sectional study design precludes definitive conclusions regarding causal relationships. Second, *DSM-IV* criteria for PTSD and subthreshold PTSD were used, as data collection began prior to *DSM-5* publication; the prevalence and correlates of *DSM-5* full and subthreshold PTSD may not be fully comparable. Third, probable PTSD diagnosis was assessed using a self-administered PCL-S survey rather than clinician interviews, which may result in under- or overreporting of symptoms. Moreover, duration and functional impairment were not required for probable subthreshold or full PTSD diagnosis. This methodology, though commonly used, may overestimate the prevalence of PTSD diagnoses.[39] Further, our study sample may have been influenced by self-selection bias. Compared to nonparticipants, participants reported more severe PTSD symptoms at their initial WTC monitoring visit; further, post-9/11 medical problems were associated with both subthreshold and full PTSD. Prior research has shown that disaster survivors with higher post-disaster distress and more medical problems may be more likely to participate in disaster-related research surveys.[40] Lastly, analyses in this study were not adjusted for multiple analyses conducted. As such, the statistical significance of individual predictor variables may be overestimated.

Notwithstanding these limitations, this study has several important implications for clinical practice and public health. First, this study found that a substantial proportion of responders screened positive for full and subthreshold WTC-related PTSD a median of 12.2 years after 9/11. Nearly a quarter of nontraditional responders who chose to complete the web-based survey reported past-month subthreshold PTSD symptoms; this finding suggests that even years after disaster response efforts, nontraditional responders could benefit from screening and monitoring for subthreshold PTSD. Regarding screening for subthreshold PTSD, previous work[41] has suggested that failing to meet *DSM-IV* criterion C (avoidance) is the most common reason why individuals with subthreshold PTSD fall short of criteria for full PTSD. Additionally, consistent with our findings here, prior research[8] indicates that individuals with subthreshold PTSD present with intermediate levels of functional impairment—falling "in between" trauma-exposed individuals with no PTSD and those with full PTSD.

Second, both subthreshold PTSD and full PTSD were associated with additional post-9/11 traumatic events and medical comorbidities. This finding suggests that post-disaster efforts to address the physical and mental health needs of first responders should focus not only on PTSD symptoms but also on assessing psychosocial stressors and medical problems.

Third, in nontraditional responders, subthreshold PTSD was associated with a significant burden of psychiatric comorbidities and functional impairment and with increased use of psychotropic medications, but no significant difference in other mental health services use. Although prior work has identified a higher risk of developing PTSD among nontraditional WTC responders,[26] further research is warranted to examine potential barriers to accessing treatment among nontraditional responders with subthreshold PTSD.

Collectively, these findings underscore the burden of subthreshold and full PTSD in WTC responders over a decade after 9/11, potentially informing assessment and treatment efforts for this group and other first responders. Our findings also underscore the practical limitations of *DSM-IV* and *DSM-5* diagnostic criteria for PTSD. Although the *DSM-5* specifies that subthreshold PTSD may be diagnosed as an Other Specified Trauma- and Stressor-Related Disorder,[42] subthreshold PTSD is infrequently assessed in clinical settings. However, WTC responders with subthreshold PTSD are eligible to receive treatment through the WTC Health Program if they meet criteria for Other Specified Trauma- and Stressor-Related Disorder. Additional research is needed to identify sociodemographic, exposure, and clinical characteristics associated with mental health treatment utilization, as well as potential barriers to treatment, in WTC and other disaster responders with subthreshold PTSD.

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Potential conflicts of interest: **Dr Feder** is named co-inventor on a patent application in the United States and several issued patents outside the United States filed by the Icahn School of Medicine at Mount Sinai related to the use of ketamine for the treatment of posttraumatic stress disorder. This intellectual property has not been licensed. **Dr Pietrzak** is a scientific consultant to CogState Ltd. **Drs Chen**, **Crane**, **Harrison**, **Luft**, **Moline**, **Singh**, **Schechter**, **Southwick**, **Todd**, and **Udasin** and **Mr Dasaro**, **Ms Rodriguez**, and **Mr Salim** report no competing interests.

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Supplementary Material

Article Title: The Burden of Subthreshold Posttraumatic Stress Disorder in World Trade Center Responders in the Second Decade After 9/11

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List of Supplementary Material for the article

1. Appendix 1 Multiple Imputation Code

Disclaimer

This Supplementary Material has been provided by the author(s) as an enhancement to the published article. It has been approved by peer review; however, it has undergone neither editing nor formatting by in-house editorial staff. The material is presented in the manner supplied by the author.

Appendix 1: Multiple Imputation Code. The full code used in multiple imputation of missing survey values is provided below:

```
capture log close
set more off
log using cr_aging_data_ice, replace
version 13.1
// CARRY OUT MULTIPLE IMPUTATIONS
clear*
set emptycells drop
set matsize 5000
set coeftabresults off
set seed 26489050
use backfilled

keep trajectories_id age_v4 female_sex traumatic_exposure_index
ss_during_wtc_family ///
 ss_during_wtc_work life_stressors_before_911 life_stressors_since_911  ///
 any_psych_dx trauma_before_911 trauma_after_911 medical_conditions_after_911
///
 sleafter activecoping_1 avoid_2 blamevent_3 socialsupp_4 emofocus_5 ///
 religion_6 subuse_7 new_police work_status maritalstatus income
panas_pos_score ///
 panas_neg_score rescue_occasions trainingsq001 trainingsq002 ///
 ptgi_score sds* /*cage_screen*/ cage_score qol_total v4_pcl_score ///
 v4_ptsd_level perceived_preparedness_sum social_support_sum ///
 purpose_in_life_sum phq2_score ethn* language cage_screen cage_pos
drop ethn*comment ethnicityother
// MISCELLANEOUS LITTLE CLEANUPS
forvalues i = 1/5 {
 replace ethnicityethnother = .h if ethnicityethn`i' == 1 ///
  & missing(ethnicityethnother)
}
replace ethnicityethnother = .h if missing(ethnicityethnother)

label var cage_screen "Cage Screen Question: Do you drink?"
foreach v of varlist trainingsq* {
 recode `v' (2/3 = 0)
}
label list work_status
recode work_status (0/1=1) (2/3=2) (5=3) (4 6 7=4)
label define work_status3 1 "Working (FT/PT)" ///
       2 "Disabled" ///
       3 "Retired" ///
       4 "Unempl/Retired/Other"
label values work_status work_status3

recode maritalstatus (1/2=1) (3/4 = 2) (5/7 = 3)
label define maritalstatus 1 "Never Married" ///
       2 "Married/Cohabiting" ///
       3 "Widowed/Divorced/Separated"
label values maritalstatus maritalstatus

save aging_data_pre_ice, replace

// IDENTIFY REGULAR VARIABLES AND VARIABLES TO IMPUTE
```

```
ds income purpose_in_life_sum  perceived_preparedness_sum ///
 sdsworkyessq001 sdssq002 sdssq003 social_support_sum qol_total ///
 v4_pcl_score panas_pos_score panas_neg_score ///
 ptgi_score phq2_score medical_conditions_after_911 ///
 rescue_occasions trauma*
local for_pmm `r(varlist)'
ds work_status maritalstatus v4_ptsd_level cage_score
local for_mlogit `r(varlist)'
ds ethn3a trainingsq001 trainingsq002 cage_screen
local for_logit `r(varlist)'
display "`for_pmm'"
display "`for_mlogit'"
display "`for_logit'"
local combo `for_mlogit'
local combo: list combo | for_logit
local combo: list sort combo
foreach v of varlist `combo' {
 replace `v' = . if `v' != int(`v')
}
local regular
local imputed
quietly ds, has(type numeric)
foreach v of varlist `r(varlist)' {
 quietly count if `v' == .
 if `r(N)' == 0 {
  local regular `regular' `v'
 }
 else {
  local imputed `imputed' `v'
 }
}
local passive cage_pos sdsworkyesno
local regular: list regular - passive
local imputed: list imputed - passive
local imputed: list sort imputed
display `"`regular'"'
display `"`imputed'"'
display `"`passive'"'
misstable summarize
foreach x in pmm  mlogit logit {
 local for_`x': list for_`x' - passive
 local for_`x': list for_`x' - regular
}
local combo: list for_pmm | for_mlogit
local combo: list combo | for_logit
local combo: list sort combo
assert `"`imputed'"' == `"`combo'"'
local imputed: subinstr local imputed "v4_ptsd_level" "o.v4_ptsd_level"
local imputed: subinstr local imputed "cage_score" "o.cage_score"
replace cage_score = . if cage_screen != 1
ice `regular' `imputed' `passive', match(`for_pmm') ///
 conditional(cage_score: cage_screen != 0 \ ethn3a: ethnicityethn3 == 1) ///
 passive(cage_pos: cage_score >= 2 \ sdsworkyesno: work_status == 1) ///
 by(language) saving(aging_data_ice, replace) m(100) persist

log close
exit
```