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# Predicting Future PTSD using a Modified New York Risk Score: Implications for Patient Screening and Management

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## Abstract

**Aim—**We previously developed a posttraumatic stress disorder (PTSD) screening instrument – the New York PTSD Risk Score – that was effective in predicting PTSD. In the present study, we assessed a 12-month prospective version of this risk score, which is important for patient management, follow-up, and for emergency medicine.

**Methods—**Using data collected in a study of New York City adults after the World Trade Center Disaster (WTCD), we developed a new PTSD prediction tool. Using diagnostic test methods, including receiver operating curve (ROC) and bootstrap procedures, we examined different prediction variables to assess PTSD status 12 months after initial assessment among 1,681 trauma-exposed adults.

**Results—**While our original PTSD screener worked well in the short term, it was not specifically developed to predict long-term PTSD. In the current study, we found that the Primary Care PTSD Screener (PCPS), when combined with psychosocial predictors from the original NY Risk Score, including depression, trauma exposure, sleep disturbance, and healthcare access, increased the area under the ROC curve (AUC) from 0.707 to 0.774, a significant improvement ($p<0.0001$). When additional risk-factor variables were added, including negative life events, handedness, self-esteem, and pain status, the AUC increased to 0.819, also a significant improvement ($p=0.001$). Adding Latino and foreign status to the model further increased the AUC to 0.839 ($p=0.007$).

**Conclusion—**A prospective version of the New York PTSD Risk Score appears to be effective in predicting PTSD status 12 months after initial assessment among trauma-exposed adults. Further research is advised to further validate and expand these findings.

### Keywords

Posttraumatic stress disorder; Psychological Trauma; Diagnostic screening; Emergency Medicine

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## Introduction

The goal of our original study was to identify brief risk assessment instruments for posttraumatic stress disorder (PTSD).[1] To meet this objective, we used a prospective study of the World Trade Center disaster (WTCD) in New York City (NYC), [2-8] which include clinical data related to mental health status, trauma exposure, demographic, and psychosocial status.[9] The WTCD dataset represented a large sample of adults (N=2,386) randomly selected throughout the five boroughs of NYC. PTSD was assessed based on the full *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria.[10] As previously discussed, the results of the original WTCD risk assessment study were also validated against other trauma studies, including a study of chronic pain patients (N=705) and level-I trauma patients (N=225).[1]

To date, a number of PTSD screening tools are available. These include the Primary Care PTSD Screen (PCPS), the Short Screening Scale for PTSD (SSSP), the abbreviated PTSD Checklist (APCL), the Short PTSD Rating Interview (SPRINT), the Screening Tool for Early Prediction of PTSD (STEPP), among others.[11-17] These screeners are relatively short, have been shown to have reasonable specificity and sensitivity, and are focused on core PTSD symptoms. However, as we note below, these screening scales have limitations.

When developing the New York PTSD Risk Score, our primary goal was to create a screening instrument that would be useful in different clinical settings.[1] Consistent with this approach, we examined multiple risk factors that extended beyond single-dimension PTSD screeners in current use.[11] Thus, our plan was to evaluate a range of signs and symptoms to develop a more robust PTSD prediction screener.[1] Our approach is consistent with the method recently used by Marx et al. in a study designed to predict combat PTSD among Vietnam veterans.[18] However, in our current study, we specifically assess the utility of a longitudinal model that could predict PTSD 12-months after initial assessment.[4]

Previous research regarding the consequences of traumatic events guided our original study.[19-21] Although research suggests that most persons recover quickly from traumatic experiences, [22] systematic reviews suggest that exposure to traumatic events can result in significant long-term impairments among some people.[23, 24] Research also suggests that PTSD is not only associated with neuroendocrine and immune system alterations,[25-26] but also with the onset of chronic health conditions.[27] Furthermore, research on community disasters and other traumatic events suggests that many survivors have increased psychological problems after these exposures and also experience significant psychosocial resource losses.[8, 24, 28]

Based on this body of research, the focus of the current study was to assess the suitability of PTSD diagnostic instruments for use in clinical practice to predict longer-term PTSD status. As has been previously noted, prediction of longer-term PTSD has been difficult.[4, 8] Typically, variables related to predisposition, those that occurred before the index trauma exposure, and variables occurring after the trauma exposure are often the best predictors of future PTSD status.[4, 8] Our goal was to develop a baseline PTSD assessment tool that could be used in a disaster, emergency, and in other settings that could be used to plan future treatment interventions and resource allocations.

## Materials and Methods

### Conceptual Approach

Research suggests that increased PTSD vulnerability occurs among those with a history of mental health disorders, child adversity, and a history of previous traumas.[29-31] Socioeconomic and racial/ethnic factors are also known to affect these experiences.[32, 33] Thus, the degree of exposure, socio-cultural factors, and other variables are often involved in determining the impact of traumatic stress exposures.[2] In addition, the psychobiological bases of these syndromes have also become apparent.[34] Consequently, one would anticipate a number of behavioral/cognitive issues to emerge among traumatized persons, including sleep disturbances, substance misuse, alterations in functional and mental health status, and the onset of other health problems.[35, 36]

Currently, PTSD is known to be associated with outcomes along several causal pathways that encompass cognitive, behavioral, and biological domains.[37] Accordingly, we used a multi-factorial approach to guide model building combined with agnostic (i.e., atheoretical) examinations of statistical results.[1] As described below, the WTCD cohort we used to develop the original New York PTSD Risk Score represented one of the major longitudinal studies that examined mental health outcomes following a major traumatic event.[2-8] These data enabled the testing of specific models that were conceptually and empirically grounded in the existing literature and included a sample size adequate for data analysis.[1] They also permitted the empirical validation of the original prediction models using other trauma-related data.[1]

### Risk Score Development

As previously described,[1] we used a process of moving candidate variables in and out of the prediction models, which allowed for the manipulation of specificity and sensitivity.[38] This process was guided by a multi-factorial prediction model approach.[1] This method permitted establishment of PTSD risk score cut-points that would be useful in clinical settings by being sensitive to both statistical and clinical significance. We used methods designed for diagnostic test development, including sensitivity, specificity, receiver operator characteristic (ROC) curves, and bootstrap techniques.[38] An initial model was developed using variables thought to be related to PTSD. This model was then extended to include the unique collection of candidate measurements of interest from the WTCD cohort study. As discussed elsewhere, [1] these variables included mental health status, substance misuse, stress exposures, neurological symptoms, community resources, and functional status measures, among others (see Table 1). The goal of this model building was to estimate the area under the ROC curve (AUC), while using the fewest number of parameters.[1] The AUC was estimated at each step to quantify the prediction accuracy of the models.[39] That is, it provided a quantitative measure of the discrimination ability of a model to classify patients with and without later PTSD onset. The sequential addition of variables to the base model was evaluated in terms of increasing the AUC.[38]

A non-parametric approach was used to compare the added effects of other variables above the contribution of the base model.[40] The results of the model were then used to construct a risk score for PTSD onset. The properties of the risk scores were examined in terms of sensitivity, specificity, AUC, and by use of a nomogram,[41] which is a graphical tool used to represent the model.[1] One problem in estimating measures of diagnostic ability using the same dataset in which the model was derived is overestimation.[42] This was corrected by estimating a bias-corrected version using a 1,000-sample bootstrap procedure to provide a more accurate estimate of the AUC. [41] Specifically, 95% confidence intervals (CIs) for the bias-corrected AUC were bootstrapped for the ROC curves reported for the WTCD

development sample. This procedure is superior to the method of cross-validation and using a training and validation dataset.[41] In addition to estimating the AUC, we also used Youden's Index.[38] The Youden Index is another summary measure of the ROC curve, as it provides a criterion for choosing a cutoff value for which both sensitivity and specificity are maximized under an equal weighting scheme.[40, 43] A single model was then developed to create a risk score using logistic regression analyses. The statistical software used in this study included, SAS, version 9.2,[44] Stata version 11.2,[45] and Pepi software, version 4.0.[46]

## WTCD Development and Validation Study

To study the impact of the WTCD event, using random-digit dialing, baseline diagnostic interviews were conducted among NYC adults (18 and older) by telephone one-year after the attacks. For the baseline survey, 2,368 residents completed the interview. A follow-up interview was conducted 12-months later among 71% of these baseline respondents (N = 1681). For this study, PTSD was diagnosed based on the full *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV).[10] This PTSD measure was developed for telephone administration and used in previous mental health surveys.[47-49] To meet criteria for PTSD in this study, the person had to meet the A-F diagnostic criteria for PTSD.[9] Cronbach's alpha for the symptoms used in this scale was 0.90,[2] and the validity of this PTSD diagnostic scale has been reported to be good.[50] Versions of this scale have been used in mental health surveys involving approximately 15,000 telephone interviews, including several WTCD surveys.[2, 47-49] We note that the WTCD PTSD diagnostic scale is used as the PTSD “gold standard” in the current study. Additional information on this study has been published elsewhere.[2-8] The Geisinger Institutional Review Board (IRB) has approved this study and serves as the IRB of current record.

## Use of Existing Screeners and other Prediction Measures

As part of our study, we reviewed existing PTSD screening instruments currently in clinical use.[11] In the original New York PTSD Risk Score study,[1] we used two of these instruments: the Short Screening Scale for PTSD (SSSP) and the Primary Care PTSD Screener (PCPS).[13, 51, 52] Since the PCPS outperformed the SSSP and was a shorter scale,[1] in the current study we only present results for the PCPS. In addition, based on our previous study, we also used core psychosocial measures we had previously identified in our NY PTSD Risk Score. This included a 2-item measure of lifetime depression symptoms, the Patient Health Questionnaire-2 (PHQ-2).[1] Other assessments included a measure of healthcare access, difficulty sleeping, and a measure of lifetime trauma exposure.[1] Access to healthcare was assessed by a question related to having a regular doctor or source of healthcare. Difficulty sleeping was assessed by a question about sleep problems in the past year. Lifetime trauma exposure was assessed by asking the subject to recall lifetime trauma experiences.

In addition to these core NY PTSD Risk Score measures, based on previous research,[4, 6, 8] we also tested additional candidate variables (see Table 1) to predict future PTSD using the statistical methods described. This resulted in the inclusion of four additional PTSD risk-factor measures (negative life events, pain impairment, low self-esteem and handedness) and two demographic measures (Latino status and foreign born) with the original NY PTSD prediction model. Negative life events were assessed by self-report of life events that occurred in the past year.[19] Pain impairment was assessed by a survey question related to pain experienced in the month.[53] Low self-esteem was assessed by a brief version of the Rosenberg Scale.[54] Handedness was assessed by one question related to which hand the subject used for most common tasks (right, left, both). [4] Latino ethnicity (Latino vs. non-Latino) and birth status (non-foreign born vs. foreign born) were assessed by survey self-report. All measures used in the prospective New York Risk Score model were assessed at

baseline and are summarized in Table 2. These specific measures are also included in the study Appendix.

## Results

The demographic profile of study subjects shows that the majority were between 30-64 years of age (70%), female (59%), non-white race (54%), and were not college graduates (54%) (Table 2). Demographically, 31% were foreign born and 22% were Latino. Also, 22% scored positive on the PCPS (i.e., they had 3 positive PTSD symptoms) at baseline and 47% had at least one positive lifetime depression symptom on the PHQ-2 scale. Furthermore, 20% had high exposure (i.e., 4+ events) to lifetime traumatic events, 32% reported difficultly sleeping in the past year, and 11% did not have regular access to healthcare. Twenty-two percent (22%) had experienced 2 or more negative life events in the past year and 18% were non-right-handed. Furthermore, 46% reported moderate to severe pain impairment in the past 4 weeks and 30% scored low in self-esteem. All these predictor variables were measured at the initial (baseline) assessment and were significant in prospectively predicting PTSD in the follow-up period. The prevalence of PTSD at follow-up was 8% (Table 2).

The results for predicting PTSD prospectively from baseline predictors are shown in Table 3. As suggested, the PCPS was selected because of its wide clinical use, previous research, and because these screener symptoms were also included in the PTSD symptoms scales used in previous trauma studies. As can be seen, the primary care PTSD screener alone has a sensitivity of 60.5% and a specificity of 80.9% in predicting PTSD at 12-month follow-up, resulting in an area under the receiver operating curve (AUC) = 0.707 (95% CI = 0.664-0.750). Adding the predictors from the original NY PTSD Risk Score, including sleep disturbance, depression symptoms, trauma exposure, and access to healthcare, resulted in a sensitivity of 76.9% and a specificity of 69.4%, with an AUC = 0.774 (95% CI = 0.730-0.810). This resulted in a significant improvement in the prediction model over the base model with only the PCPS ($p < 0.0001$). Adding the four additional longitudinal risk factors identified, including negative life events in the past year, baseline pain status, baseline self-esteem, and reported handedness, resulted in a sensitivity of 67.2% and a specificity of 82.7%, with an AUC = 0.819 (95% CI = 0.781-0.856). This also resulted in a significant improvement over the previous model that included the PCPS and the original NY Risk Score factors ($p = 0.001$). Finally, adding demographic factors, in this case Latino ethnicity and birth status, resulted in a sensitivity of 87.3% and a specificity of 65.3%, with an AUC = 0.839 (95% CI = 0.804-0.873), also a significant improvement over the previous model with the PCPS and the original NY Risk Score plus additional predictor variables ($p = 0.007$).

Because the prevalence of PTSD at follow-up was relatively low (8%), the predictive value of a positive test (PV+) was generally less than 25%, while the predictive value of a negative test (PV-) was typically 96% to 98% (see Table 3). However, we note that given our prediction model, if our study populations had a PTSD prevalence of ~20%, statistical simulations (using Pepi, version 4) suggested that the positive predictive value of a positive test would be generally 80% to 90%, a substantial improvement.

Table 4 presents PTSD risk-score results (i.e., the final regression-derived weights) used to generate the classification results shown in Table 3. As seen, a positive score on the PCPS (i.e., 3 or more positive items) is given a base score of 100 (otherwise = 0) and the psychosocial, demographic, and additional measures are also given weights (or scores) relative to this score. This scoring is based on using logistic regression analyses, whereby the b coefficients in each of the logistic regression models predicting PTSD are converted to

standardized weights using a nomogram, as noted. These weights are then used to calculate a PTSD risk score. The last row of Table 4 shows the total cut-off score for a PTSD classification at follow-up, based on these risk-score weights: 100 for the PCPS used alone; 110 for the PCPS + NY Risk Score factors; 224 for the PCPS + NY Risk Score factors + additional risk factors; 182 for the PCPS + NY Risk Score factors + additional risk factors + demographic factors.

## Discussion

We examined different clinical domains to evaluate prediction models that could prospectively predict PTSD. Our overall goal was to develop a prospective PTSD prediction tool that was effective and that could guide clinical interventions and resource planning in different medical settings.[1] As shown, multiple prediction domains were identified, including core PTSD symptoms (i.e., the PCPS), psychosocial risk factors from the original NY Score (healthcare status, sleep disturbance, depression symptoms, and past trauma exposures), additional longitudinal risk factors (negative life events, handedness, pain status, and self-esteem), as well as two demographic factors (Latino status and foreign born). In prospectively predicting PTSD, the performance of the PCPS was limited, with an AUC ranging from 0.664 to 0.750 due to the low sensitivity of this measure (60.5%). However, adding baseline psychosocial variables from the NY PTSD Risk Score increased the AUC from 0.707 to 0.774 (specificity = 69.4%, sensitivity = 76.9%), a significant improvement ($p < 0.0001$). Further, adding additional risk factors to the model increased the AUC from 0.774 to 0.819 (specificity = 82.7%, sensitivity = 67.2%), also a significant improvement ($p = 0.001$). Adding demographic variables increased the AUC from 0.819 to 0.839 (specificity = 65.3%, sensitivity = 87.3%), again, a significant improvement ($p = 0.007$).

The use of PTSD screeners has increased with growing interest in the impact of traumatic stressors in different healthcare settings. Currently in the US, the Department of Veterans Affairs and the Department of Defense are routinely using the PCPS in clinical practice to assess veterans and active duty personnel.[12] As seen in this prospective study, the PCPS alone appears to be limited. The addition of the core psychosocial predictors from the original NY Risk Score and the other risk factors discussed to the PCPS, increases the predictive ability of the score in forecasting PTSD. However, adding demographic factors, while statistically significant ($p = 0.007$), did not result in a substantial prediction improvement (AUC = 0.839 - 0.819 = 0.02). The PCPS screener consists of 4 PTSD symptom questions, which would require only a few minutes to administer in most cases. If the psychosocial questions from the original NY Risk Score are added, which include 2 depression questions, a trauma question, a sleep question, and an access to care question, this would likely require less than 5 minutes for administration. The inclusion of additional longitudinal risk-factor questions (4 additional variables) would add several more minutes to this evaluation. This might be done if the patient scored a 110 or higher on the PCPS and the original NY Risk Score predictors combined (Table 4, column B). The full instrument, minus the demographics, would consist of 14 questions (see appendix) requiring less than 8 minutes for administration in most cases. Thus, if the patient scored a 110 or higher on the PCPS and the core NY psychosocial measures combined, then the clinician may consider using the remaining scale items. Positive results (i.e., score = 224) on the scale with the additional risk factors added (Table 4, column C) would be an indication that delayed onset or persistent PTSD was probable in 12 months, perhaps prompting additional patient interventions or follow-up.

The current study has several strengths and limitations. A major strength was that our original study involved a large-scale random survey among a multi-ethnic urban population and three validation studies, which included a total combined sample of 3,298 subjects [1].

The latter included the WTCD bootstrapped validation study, as well as a chronic pain and a trauma study validation. We also assessed a broad range of psychological and interpersonal risk factors using standardized instruments and medical test methods. Potential study limitations include that we omitted individuals without a telephone, and those who were institutionalized or homeless. In addition, the original pain and trauma studies discussed were also conducted by telephone and excluded those too ill to be interviewed or who were institutionalized at baseline assessment. Moreover, non-response bias also could have affected all our survey results.[1] Furthermore, the item wording for the PTSD symptoms used for the PCPS screener in our survey was slightly different than the actual PCPS assessment tool. Any one of these factors may have biased our study results.

## Conclusion

Despite these limitations, our study suggests that a screening instrument, The New York PTSD Risk Score, Modified Version, may be effective in screening for PTSD, including delayed or persistent PTSD up to one year after initial assessment. This screening instrument had good sensitivity and specificity and was effective in discriminating future PTSD cases from non-cases. As suggested, the goal of this effort was to develop risk assessment tools that were both sensitive to statistical and clinical significance in order to develop data useful for clinical decision-making. Our original plan was to develop PTSD prediction models to facilitate early intervention and follow-up by making it possible to identify higher-risk groups from among all persons exposed to previous trauma. This approach would make it possible for clinicians to use limited mental health resources for those at highest future risk, while allowing lower-risk patients to be managed more conservatively. As suggested, PTSD onset and course is complex and appears to be related to trauma exposures, individual predispositions, and other factors not directly related to the original traumatic event.[4]

Recent research focusing on delayed and persistent PTSD has suggested that post-trauma events, such as psychosocial resource losses, including lower self-esteem, are predictive of later PTSD onset.[4, 6] It has also been noted that exposure to psychological trauma may intensify other negative social events, which can increase stress disorders or maintain existing ones.[8] There are also known preexisting, presumably biological factors, associated with PTSD onset, such as lower intelligence, handedness, attention deficit disorders (ADD), and other underlying conditions.[4, 55]

Our objective was to develop a baseline PTSD assessment tool that could be used within a clinical setting to plan treatment interventions and future resource allocations. Our current study suggests that PTSD onset and course appears to include psychosocial, environmental, and preexisting vulnerabilities. The current study suggests that more effective PTSD screening should include use of screeners that incorporate a fuller range of clinical predictor variables beyond core PTSD symptoms. Further research is recommended to verify our findings and to make the appropriate contextual adjustments for more effective clinical screening, surveillance, and ultimately for more effective interventions in the future.

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## Appendix: New York PTSD Risk Score (Modified Version)

## Primary Care PTSD Screener (PCPS) (3 positive symptoms out of 4, past 12 months)

**1** In the past 12 months, have you had repeated bad dreams or nightmares or had disturbing or unpleasant memories, thoughts or images that kept coming into your mind whether you wanted to think of them or not?

**2** In the past 12 months, have you deliberately tried hard not to think about something that happened to you or went out of your way to avoid certain places or activities that might remind you of something that happened in the past?

**3** In the past 12 months, have you felt you had to stay on guard much of the time or unexpected noises startled you more than usual?

**4** In the past 12 months, have you felt cut off from other people, found it difficult to feel close to other people, or you could not feel things anymore or you had much less emotion than you used to have?

## Depression Symptoms (lifetime)

**5** Have you ever had a period of two weeks or longer when you were feeling depressed or down most of the day or nearly everyday?

**6** Have you ever had a period of two weeks or longer when you were uninterested in most things or unable to enjoy things you used to do?

## Trauma Exposure (lifetime)

**7** How many traumatic events do you think you have ever experienced? These are events outside of everyday experiences and include being in combat or a war zone, being assaulted or sexually attacked, being in a major disaster, fire, or accident, experiencing the sudden and unexpected death of a loved one, and things like these.

**a** Would you say that in your lifetime, you never experienced these events, you experienced them only once, you experienced them 2-3 times, or you experienced them 4 times or more?

## Sleep Disturbance (past 12 months)

**8** In the past 12 months, have you had difficulty falling asleep or staying asleep?

## Source of Healthcare/Regular Doctor (current)

**9** Do you have a regular doctor or a usual source of care that you can go to for routine medical care?

## Negative Life Events (past 12 months)

**10** Did any of the following events happened to you in the past 12 months?

**a** Did your spouse or mate die?

**b** Did another close family member die?

**c** Did you get divorced or separated?

**d** Were you seriously injured or seriously ill?

**e** Did you get married?

**f** Did you have family problems?

**g** Did you have problems at work?

**h** Did you have other problems like these?

*Count and code negative life events as: none, 1 event, 2+ events.*

## Pain Impairment (past 4 weeks)

**11** In the past 4 weeks, how much did pain interfere with your normal work, including both work outside the home and housework?

**a** Would you say pain interfered not at all, it interfered or a little bit or moderately, or that pain interfered quite a bit or extremely?

## Low Self-esteem (current)

**12** Please tell me if you strongly agree, somewhat agree, somewhat disagree or strongly disagree with the following?

**a** I feel that I am a person of worth, at least on an equal basis with others?

(Strongly agree = 0; Somewhat agree = 1; Somewhat disagree = 2; Strongly disagree = 3)

**b** All in all, I am inclined to feel that I am a failure?

(Strongly agree = 3; Somewhat agree = 2; Somewhat disagree = 1; Strongly disagree = 0)

**c** On the whole, I am satisfied with myself?

(Strongly agree = 0; Somewhat agree = 1; Somewhat disagree = 2; Strongly disagree = 3)

*If total score for items a + b + c = 7 or less, code self-esteem as low.*

## Handedness

**12** Do you consider yourself right-handed, left-handed, or both right-handed and left-handed, that is can use either hand?

## Demographics

**13** Are you of Spanish or Latino origin?

**15** Where you born in the in this country or elsewhere?

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## Table 1
### Measurements and Assessment Timeframes used in WTCD Study*

| Measurement Domains | | | | |
|---|---|---|---|---|
| **1. Mental health status measures** | DSM-IV PTSD (lifetime, 12 months after WTCD, 24 months after WTCD) | DSM-IV major depression (lifetime, 12 months after WTCD, 24 months after WTCD) | PTSD and depression screeners (12 months after WTCD, 24 months after WTCD) | BSI-18 symptom scale (12 months after WTCD, 24 months after WTCD) |
| **2. Other mental health measures** | DSM-IV Panic attack (lifetime, 12 months after WTCD, 24 months after WTCD) | Peri-event panic attack during or immediately after WTCD | Suicidal thoughts (post-WTCD only) | Fear of death (post-WTCD only) |
| **3. Substance use/misuse measures** | Tobacco use (lifetime, 12 months after WTCD, 24 months after WTCD) | Alcohol consumption (12 months before WTCD, 12 months after, 24 months after WTCD) | Binge drinking (12 months before WTCD, 12 months after, 24 months after WTCD) | Alcohol dependence (12 months before WTCD, 12 months after, 24 months after WTCD) |
| **4. Healthcare visits and Treatment measures** | Outpatient medical visits/ hospitalizations (lifetime, 12 months after WTCD, 24 months after WTCD) | Outpatient mental health visits & hospitalizations (lifetime, 12 months after WTCD, 24 months after WTCD) | Psychotropic medication use (lifetime, 12 months after WTCD, 24 months after WTCD) | Mental health interventions & access to care (12 months after WTCD, 24 months after WTCD) |
| **5. Stress exposure measures** | Level of exposure to WTCD events (12 months after WTCD) | Traumatic event exposures (lifetime, 12 months after WTCD, 24 months after WTCD) | Stressful life events (12 months before WTCD, 24 months after WTCD) | Stress report during household interview |
| **6. Social/community resources measures** | Social support (12 months after WTCD, 24 months after WTCD) | Assistance from friends & neighbors (12 months after WTCD, 24 months after WTCD) | Social capital scale (lifetime) | Community-level census & health data for year 2000 |
| **7. Psychological and personality measures** | Rosenberg self-esteem scale (12 months after WTCD, 24 months after WTCD) | Anomie hostility scale (lifetime) | Anti-social personality screen (lifetime) | History of attention deficient disorder (lifetime) |
| **8. Functional health status measures** | SF-12: mental & physical functioning (12 months after WTCD, 24 months after WTCD) | Reported work productivity (12 months after WTCD, 24 months after WTCD) | Sleep disturbance and pain status (12 months after WTCD, 24 months after WTCD) | Leisure and household activities (12 months after WTCD, 24 months after WTCD) |
| **9. Demographic measures** | Age, gender, income, education, ethnicity, race, immigration | Physician status, insurance coverage, | Religion, church attendance (current) | Householdcomposition(current) |

| **Measurement Domains** | | | | |
|---|---|---|---|---|
| | status, language spoken (current) | employment status (current) | | |
| **10. Other measures** | Use of alternative services (12 months after WTCD, 24 months after WTCD) | Disaster rescue & recovery involvement (12 months after WTCD) | Handedness scale (lifetime) | Physician reported medical conditions (lifetime) |

* BSI-18 = Brief Symptom Inventory-18; SF-12 = Short-Form-12; DSM-IV = Diagnostic and Statistical Manual of Mental Disorder, Version IV; WTCD = World Trade Center Disaster.

## Table 2

**Profile of WTCD Cohort and Variables used in Modified New York PTSD Risk Score Prediction Model (N=1681)**

| Study Variables* | Baseline Assessments | % | 95% CI | (n) |
|---|---|---|---|---|
| *Sample Demographics* | Age | | | |
| | 18-29 | 16.9 | 15.2-18.8 | (284) |
| | 30-44 | 35.5 | 33.2-37.8 | (596) |
| | 45-64 | 34.9 | 32.6-37.2 | (586) |
| | 65+ | 12.8 | 11.3-14.5 | (215) |
| | Female Gender | 58.8 | 56.4-61.1 | (988) |
| | Race | | | |
| | White | 46.5 | 44.1-48.9 | (782) |
| | Non-white | 53.5 | 51.1-55.9 | (899) |
| | College Graduate | 46.1 | 43.7-48.5 | (775) |
| *PCPS from Original NY PTSD Risk Score* | Positive Primary Care Screen | 22.4 | 20.4-24.4 | (376) |
| *Core Psychosocial Measures from Original NY PTSD Risk Score* | PHQ-2 Symptoms | | | |
| | None | 52.9 | 50.6-55.3 | (890) |
| | One | 16.7 | 15.0-18.6 | (281) |
| | Two | 30.3 | 28.2-32.6 | (510) |
| | Trauma History | | | |
| | < 2 Event | 51.5 | 49.2-53.9 | (866) |
| | 2-3 Events | 28.8 | 26.7-31.0 | (484) |
| | 4+ Events | 19.7 | 17.9-21.7 | (331) |
| | Sleeping Problems | 31.7 | 29.5-34.0 | (533) |
| | No Access to Healthcare | 10.5 | 9.1-12.1 | (177) |
| *Additional Longitudinal Risk-Factors Measures for Modified NY PTSD Risk Score* | Negative Life Events | | | |
| | None | 50.5 | 48.1-52.8 | (848) |
| | 1 Events | 27.8 | 25.7-30.0 | (467) |
| | 2+ Events | 21.8 | 19.9-23.8 | (366) |
| | Handedness | | | |
| | Right | 82.3 | 80.4-84.1 | (1384) |
| | Left | 10.9 | 9.5-12.5 | (183) |
| | Mix | 6.8 | 5.7- 8.1 | (114) |
| | Pain Impairment | | | |
| | None | | | |
| | Little/Moderate | 32.4 | 30.2-34.7 | (545) |
| | Extreme | | | |
| | Self-esteem Low | 29.5 | 27.4-31.7 | (496) |
| *Demographics for Modified NY PTSD Risk Score* | Latino | 21.8 | 19.9-23.9 | (367) |
| | Foreign Born | 31.4 | 29.2-33.7 | (528) |

| **Study Variables*** | **Baseline Assessments** | **%** | **95% CI** | **(n)** |
|---|---|---|---|---|
| *PTSD 12 Months Post Baseline Assessment* | PTSD | 8.0 | 6.8-9.4 | (134) |

* WTCD = World Trade Center Disaster; PCPS = Primary care PTSD Screener; PHQ-2 = Patient Health Questionnaire-2.

Table 3

**Prediction Results using Different PTSD Models (N = 1681)***

| Prediction Model Used | Cut-off Score | % Specificity | % Sensitivity | PV+ | PV- | AUC | AUC 95% CI | P-value** |
|---|---|---|---|---|---|---|---|---|
| **PCPS only** | 100 | 80.9 | 60.5 | 21.6 | 95.9 | 0.707 | 0.664-0.750 | -- |
| **PCPS + NY Risk Score** | 110 | 69.4 | 76.9 | 17.9 | 97.2 | 0.774 | 0.730-0.810 | <0.0001 |
| **PCPS + NY Risk Score + Additional Risk Factors** | 224 | 82.7 | 67.2 | 25.2 | 96.7 | 0.819 | 0.781-0.856 | 0.001 |
| **PCPS + NY Risk Score + Additional Risk Factors + Demographic Factors** | 182 | 65.3 | 87.3 | 18.0 | 98.3 | 0.839 | 0.804-0.873 | 0.007 |

* AUC = Area under ROC curve; PV+ = Predictive value of positive test; PV- = Predictive value of negative test; PCPS = Primary care PTSD Screener.

** P-values show improvement in AUC.

## Table 4

**Modified NY PTSD Risk Score Weights for Primary Care PTSD Screener (PCPS), Original NY Risk Score Factors, Additional Longitudinal Factors and Demographic Factors**

| Predictor Variables | (A) PCPS Screen Only | (B) PCPS Screen + NY Risk Score | (C) PCPS Screen + NY Risk Score + Additional Factors | (D) PCPS Screen + NY Risk Score + Additional Factors + Demos |
|---|---|---|---|---|
| **Positive PCPS Results** | **100** | **100** | **100** | **100** |
| *Psychosocial Measures from Original NY PTSD Risk Score* | | | | |
| PHQ-2 = 1 | -- | 24 | 5 | 3 |
| PHQ-2 = 2 | -- | 66 | 37 | 39 |
| Trauma Count = 2-3 | -- | 10 | 1 | 6 |
| Trauma Count = 4+ | | 47 | 26 | 40 |
| Sleep Disturbance = yes | -- | 56 | 43 | 41 |
| No Regular Healthcare = yes | -- | 46 | 60 | 43 |
| *Additional Longitudinal Risk-Factors Measures for Modified NY PTSD Risk Score* | | | | |
| Negative Events = 1 | -- | -- | 53 | 56 |
| Negative Events = 2+ | -- | -- | 70 | 75 |
| Handedness = left | -- | -- | 18 | 31 |
| Handedness = mixed | -- | -- | 100 | 93 |
| Pain Interferes = a little/moderate | -- | -- | 20 | 11 |
| Pain Interferes = a lot/extreme | -- | -- | 71 | 56 |
| Low self-esteem = yes | -- | -- | 71 | 69 |
| *Demographics for Modified NY PTSD Risk Score* | | | | |
| Latino = yes | -- | -- | -- | 53 |
| Foreign Born = yes | -- | -- | -- | 60 |
| **PTSD Cut-off Score =** | **100** | **110** | **224** | **182** |

* Primary Care PTSD Screener (PCPS) with 3 positive items equals a Risk Score = 100. PHQ-2 = Patient Health Questionnaire, 2-item version.