Final Progress Report

Context and Ethnic Diversity: Children's Responses to 9/11

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Abstract

Understanding the effects of mass trauma, such as 9/11, on the development and mental health outcomes of exposed youth is a Public Health priority of the first order. Previous studies, including a study by our own research group, known as the New York City Board of Education Study (NYC-BOE, PI: Hoven), have documented increased rates of mental health (MH) disorders in school children six months after 9/11. While some exposed children respond with resilience and go on to normal adult development, others are plagued by ongoing MH issues. Yet, relatively little is known about how selected environmental contexts, in which children live during and after a trauma, impacts the effect that the trauma has on their long- and short-term MH outcomes. If post-disaster interventions are to significantly improve, we need to know more about which contexts should receive immediate interventions post-disaster Fortunately, two very recent advances in psychiatric research serve to aid in addressing this issue. 1- The development of a more contextualized view of the role that race/ethnicity play in MH, as exemplified by the DSM-5's "Cultural Formulation Interview" (CFI). The CFI captures the rich interactive contexts which place race/ethnicity in a broader framework of the experienced cultural and physical environment. Applying this framework focuses our attention, not only on trauma and its outcome, but on the intervening environmental experience that determines how the trauma ultimately affects development. 2- There is the beginning of a movement away from simple diagnostic categorization towards a dimensional view of MH, dysfunction, and wellness, as exemplified by the Research Domain Criteria project (RDoC) launched by NIMH, in 2010. RDoCs encourages evaluating a more comprehensive set of emotional and behavioral difficulties than those captured by diagnostic symptoms alone. This **Trauma, Context and Outcome (TCO)** Study used data from the NYC-BOE Study (which includes extensive information on family characteristics) in conjunction with databases on neighborhood and school characteristics, to examine how race/ethnicity interacts with the child's environment (family and neighborhood) to affect the impact of trauma on dimensional MH outcomes among youth exposed to 9/11. Our ultimate goal is to understand how these environmental factors influence a post-traumatic pathway to either resilience or MH difficulties. This research will facilitate a new and more complete understanding of post-9/11 MH among NYC's children.

Significant (Key) Findings

Despite being the second fastest growing ethnic group in the United States, Latinos continue to remain underrepresented both in mental health research and in service utilization. There is also insufficient attention to the diversity of the children exposed to trauma, and less so in consideration of within group differences.

In general, we found over 11% of both Latino and White youth had generalized anxiety and conduct disorder after exposure to 9/11 WTC attack, underscoring these findings that youth exposed to traumatic events are a high-risk group. When we considered ethnic group differences, Latino youth were significantly more likely to report agoraphobia and separation anxiety compared to White youth. However, unlike previous research that shows Latino populations have higher rates of PTSD symptoms compared to their Black or White counterparts, we did not find this trend among Latino youth. Although, Latino youth endorse more PTSD symptoms, compared to White youth.

Our results support the establishment of a new grief-related disorder: (1) precipitating events, (2) clinical correlates, (3) symptoms structure, and (4) phenomenology of grief are distinct from those of PTSD and MDD. It is important to highlight point 2: grief constitutes a clinically significant syndrome, associated with functional impairment independently of PTSD and MDD.

The present study is among the first to examine the association between exposure to a mass trauma and panic disorder in children. We found that both severe event exposure and high media exposure to 9/11 were associated with increased likelihood of probable panic disorder among school children in New York City six months after the event. Characteristics that conferred vulnerability to panic following the WTC attack included sex and prior trauma, but not other demographic or family characteristics examined. We also found that panic was associated with significantly increased likelihood of a range of mental disorders, with two exceptions, levels of comorbidity between these disorders and probable panic did not vary by severity of exposure or media exposure. The pattern of comorbidity did vary among students attending ground-zero area schools compared to those attending schools outside this area. The association between panic and separation anxiety, and panic and alcohol abuse/dependence disorder was significantly different in GZA and non-GZA students. Below we discuss findings in greater detail and their potential implications.

Translation of Findings

Findings of this study have clear implications for both clinical work and future research concerning the associations between the long-term sequelae of exposure to trauma and psychopathology. From a clinical perspective, these data suggest that children exposed to mass trauma are at increased risk for the later development of panic, and those with a history of trauma are particularly vulnerable. Since there are effective and available treatments for panic, it may be clinically feasible to focus on

panic among children in psychological evaluations and care in the aftermath of a massive traumatic event. Given panic has been associated with subsequent psychiatric problems, as well as academic and social functioning, successful intervention may have long term implications.

These results underscore the importance of unpacking traditional DSM classifications and consideration of ethnic background and nativity in children exposed to traumatic events. The findings also highlight the role of family among more acculturated Latino youth. Having a greater awareness of the cultural effects on the development or mitigation of mental disorders can not only lead to more robust culture-specific intervention strategies, but it can also promote family involvement and de-stigmatizing the seeking of treatment.

NYC is a vast and complex urban landscape comprised of many culturally- and socioeconomically-clustered neighborhoods. The present assessment of neighborhood effects on PTSD sheds light on the many ways in which the urban landscape can impact a child's mental health, and, therefore, their long-term sequelae. This study provides a useful framework and set of methodologies for expanding our overall understanding of PTSD, the geographies of mental health, and the determinants of risk and resilience following large-scale events like 9/11, and provides evidence that geographic factors beyond mere proximity to a traumatic event are important determinants of PTSD risk. Our findings indicate that disadvantaged and low quality neighborhoods need to be a top priority for intervention efforts by local, state, and national government and health agencies, following any major disaster.

Outcomes/Impact

This study identified the role that race/ethnicity, family and neighborhood contextual factors, had on the mental health outcomes of youth exposed to 9/11. Using data from the New York City Board of Education Study (NYC-BOE Study; PI: Hoven) this study clarified the role that selective children's context played in determining if they had a resilient, versus an adverse response to 9/11. This understanding is key to the development of improved and targeted prevention and treatment strategies, as well as public policies, for all children exposed to mass trauma, but especially minority populations.

Scientific Report

1. Background:

Following exposure to a disaster, children and adolescents are among the most vulnerable individuals, potentially carrying traumatic effects for a lifetime, or conversely, growing up to be well-functioning adults. Understanding, preventing and ameliorating the impact of a mass trauma, such as 9/11, on the well-being of vulnerable youth, is a Public Health priority of the first order. Important findings from our New York City-Board of Education (NYC-BOE) Study, conducted 6-months after 9/11, led to this Principal Investigator testifying before the US Senate[1], which quickly resulted in approximately $150 million being allocated to child mental health services in NYC. While the immediate post-9/11 psychological support and services targeted those at or near the Ground Zero Area (GZA), results from the NYC-BOE study clearly demonstrated the need for increased support throughout the entire City. How and why so many indirectly exposed youth had such profound responses to 9/11 requires elucidation. Fortunately, in the years since these data were collected, new approaches to psychiatric research may help to answer this question. Research has recently evolved in two orthogonal, but compatible, directions: 1) toward a more contextualized view of the role that race/ethnicity plays in mental health outcomes, as exemplified by the Cultural Formulation Interview (CFI)[2] that captures one's personal contexts, even within the categorical approach of DSM-5, and 2) away from simple diagnostic categorization and towards a dimensional view of mental functioning, wellness and dysfunction, as exemplified by the Research Domain Criteria (RDoC) launched in 2010 by NIMH[3-5].

The NYC-BOE Study, which generated a number of seminal publications, dissertations, etc.,[6,7,7-17], was unique, in part because it was the first to include a large, representative sample from an extensive geographic area, in this case, all of NYC, not just the vicinity of the World Trade Center, or the GZA. Additionally, for the first time, eight psychiatric disorders were assessed (and significantly elevated), rather than the usual one to three disorders. Consequently, this dataset continues to be almost universally recognized as the largest, broadest, most representative post-disaster child mental health dataset available. While the primary goal of the NYC-BOE Study, to identify children's immediate responses and service needs based on established DSM diagnostic criteria, was achieved, these data have yet to be mined for the rich information they contain regarding contextual and environmental factors that potentially contributed to or mediated the children's responses to 9/11. For example, surprisingly, the NYC-BOE study found that children in the outer NYC Boroughs were more likely to have psychopathology associated with 9/11 than students in the GZA. There are a number of plausible explanations for what seems like an anomalous finding, including contextual factors. However, these have never been tested. Importantly, because these data were collected from a large, representative anonymous sample of NYC public school students, they include significant sub-samples of **Asians (n=1,058); Blacks (n=2,302); Hispanics (n=3,302); Mixed Race (n=472) and Whites (n=1,102)**. In part, because the study was done *pro bono*, the mental health outcomes have never been examined from the perspective of contextual factors, now generally understood to

mediate the role race/ethnicity plays in children's psychopathology, nor have the outcomes been examined from a dimensional perspective.

This **Trauma, Outcomes and Context (TOC) Study** analyzed data from the NYC-BOE Study of NYC public school students (N=8,236) in grades 4-12, to examine how racial/ethnic background, in interaction with contextual environmental factors (neighborhood and family), potentially affected both the diagnostic and dimensional mental functioning outcomes of youth in New York City on 9/11.

Specific Aims:

AIM 1. To explore the role that family and neighborhood contextual factors, interacting with race/ethnicity, played in categorically defined DSM mental disorders of New York City Public School Children six months after 9/11.

AIM 2. To identify relevant dimensions of mental functioning, consistent with RDoC Domains and Constructs, in New York City Public School Children six months after 9/11.

AIM 3. To explore the role that family and neighborhood contextual factors, interacting with race/ethnicity, played in determining the outcomes on RDoC dimensions of mental functioning, as determined in Aim 2, among New York City Public School Children six months after 9/11.

2. Methodology

2.1 Samples:

The TOC Study utilized a citywide clustered, stratified, representative, anonymous sample of NYC students in grades 4-12 (N = 8,236, attending 94 schools), drawn from the 1.1 million public school students in NYC (NYC-BOE Study)[6,65]. A majority of the students attended and were present in a school within 10 miles of the WTC attack. Because the original study required adequate power to understand Ground Zero Area (GZA) students, more students were sampled from schools within 1 mile of the WTC site than those 1 to 15 miles away. A sampling weight was applied to better estimate the distribution, thus controlling for bias[68]. The CDC provided sampling expertise for this study.

2.2 Measures:

All individual and family level measures were derived from the original NYC-BOE Study Hoven (2002)[6,65]. The NYC-BOE study was conducted in the public schools six-months after 9/11; therefore all students were already back to their regular schools and the school each student attended on 9/11 is known. Due to the IRB limitations of the anonymous, cross-sectional design of the Study, only the home zip code of the student was collected, and thus will be used as their neighborhood identifier. Three neighborhood-level indicators were constructed and measured: socioeconomic status, safety and quality. Recent studies have shown that neighborhood effects play important roles in influencing the mental health of youth[69]. All neighborhood level items were collected from the 2000 US Census[70] and the NYC Department of City Planning (2002)[71,72].

2.2.1 Individual Level Measures: Age, gender, race/ethnicity, immigrant status, religiosity, exposure to 9/11 (level of direct, family, and media), and categorical description (DSM-IV) of psychopathology, collected six months after 9/11[6,65] were included. Hoven (2005)[6] has defined in detail how exposure and (probable) disorders were measured. For this proposed TOC Study, dimensions of mental functioning were computed (see Latent Class Analyses description below) using the 62-items self-report that was previously used to define the eight DSM disorders to derive measures of dimensional mental functioning, consistent with the RDoC.

Exposure to the WTC attack and previous exposure:

Loss and indirect exposure. Participants reported whether they knew anyone who – on 9/11 – was killed, hurt or escaped unhurt, and specified who died. For the analysis, the following non-mutually exclusive variables were created: (1) death of a family member (N=277; 3.41%), (3) death of a friend (N=544; 7.09%), (4) death of someone else (N=875; 12.35%). In a similar way, we examined weather a family member, a friend, or someone else was hurt in the attack (3 variables), or was in WTC are but escaped unharmed (3 variables).

Direct and media exposure. Direct exposure was assessed with the following dichotomous items: (1) personally witnessed the attack, (2) hurt in the attack, (3) in or near the cloud of dust and smoke, (4) evacuated to safety. Media exposure was defined as "*a lot of time*" spent learning about the attack from (1) television, or (2) web sites, radio, newspapers or magazines.

Psychiatric outcomes

Symptoms and Disorders. The Diagnostic Interview Schedule for Children Predictive Scales (DPS) [1] was used to assess PTSD and other seven probable disorders, including conduct disorder (CD), separation anxiety disorder (SAD), and major depressive disorder (MDD). The DPS is a self-report youth screening measure derived from the National Institute of Mental Health's Diagnostic Interview Schedule for Children, Version IV (DISC-IV) [2] and includes those DISC-IV items that were determined to be most predictive of DSM-IV DISC diagnoses [1]. Dichotomous questions, worded to refer to the WTC attack as the anchoring traumatic event, were used to evaluate eight PTSD symptoms in the month before the survey: (1) recurrent recollections, (2) nightmares, (3) avoidance of thoughts, feelings, or conversations, (4) avoidance of activities or places, (5) avoidance of people, (6) foreshortened future, (7) difficulty sleeping, and (8) difficulty concentrating. All DPS symptoms assessed are also included in DSM-V. Subjects endorsing ≥five PTSD symptoms are considered cases; the DPS scale and the DISC-IV have similar discriminatory power (sensitivity, 85%; specificity, 98.4%) [1, 3].

Grief. Bereaved youth (N=1,696) were asked about the intensity (0=*not at all*, 1=*somewhat*, 2=*a lot*) of five grief symptoms in the previous month: (1) "*I miss the person who died*", (2) "*I don't do things because they remind me of the person who died*", (3) "*I can't stop thinking about the person who died*", (4) "*She/he still is an important part of my life*", and (5) "*I try not to talk about the person who died because it is too painful*".

We applied a 2-parameter item response theory (IRT) analysis – implemented with the R package *ltm* [4] – to Grief items dichotomized as following: (i) answers equal to 0 were considered negative and answers equal to 1 or 2 were considered positive; (ii) answers equal to 0 or 1 were considered negative and answers equal to 2 were considered positive. Two items ("Miss the person"; "Still important") showed the lowest severity parameters. These behaviors may be considered almost normative six months after 9/11, and may be less indicative of psychopathology. Grief items dichotomized as in (ii) are most informative at more severe levels of the latent Grief trait, compared to criteria dichotomized as in (i). Overall, the severity parameters for Grief symptoms dichotomized as in (i) are probably below the range one would expect for a clinical measure. The set of Grief symptoms dichotomized as in (i) does not seem suitable for identifying subjects with severe Grief, and it might be more useful if dimensional scaling across the lower range of severity of the latent trait is desired. The TIC of Grief symptoms dichotomized as in (ii) peaked instead around 1 SDs above the mean of the latent trait, suggesting that the set of items dichotomized this way provides the best

information for the dimensional scaling of individuals with moderate to severe Grief reactions. Based on these results, items scored as 2 were considered positive. In addition to symptom count (0-5) we derived two dichotomous outcomes: a less specific cut-off of ≥2 symptoms, and a more sensitive cut-off of ≥3 symptoms, respectively; the latter was created to reflect prevalence of PCBD and similar constructs from other studies (about 10%) [5].

Impairment and other negative outcomes

Functional impairment. Impairment was assessed with a global measure of impairment derived for the DPS [1, 6]. On a scale from 0=*not at all* to 3=*a lot of the time*, participants reported the frequency of seven impairment indicators in the previous month due to the way they had been feeling or acting because of 9/11: (1) parents felt worried or concerned, (2) parents got annoyed or upset, (3) teachers got annoyed or upset, (4) the respondent was unable to do things or go to places with the family or (5) with piers, (6) felt bad or upset, and (7) had problems with schoolwork or grades. Items were considered positive if coded as 3; endorsement of ≥two indicators is considered indicative of impairment [7] in addition, we examined number of positive items, and total score (0-21).

New health problems. Subjects were asked about the occurrence (Yes/no) of new health problems since 9/11: headaches, stomachaches, breathing problems or asthma attacks, trouble sleeping, eating too much or too little, sore throat or cough, other problems. For analysis, we considered any new health problem, and the total number of new health problems. In addition, we examined the following outcomes: if the problem/s was/were still present, and if the participant had to see a doctor/nurse.

Future outlook. Outlook was assessed with three items, on a 0-2 scale (0=*not at all*, 1=*somewhat*, 2=*a lot*): (1) "*In uncertain times, I usually expect the best*", (2) "*I always look on the bright side of things*", and (3) "*I'm always hopeful about my future*". For analysis items were reverse-coded and summed to obtain a total score (Range: 0-6).

Coping. Coping strategies since 9/11 were assessed with the Youth Coping In Traumatic Times (YCITT) [8, 9]. For the current, we considered the number of positive answers to 5 dichotomous items that a previous factor analysis in the in the same sample identified as belonging to one common latent factor: (1) cry, scream, yell, or get angry, (2) get into fights, (3) skip school, (4) avoid people, (5) alcohol/smoking/stay out late [9].

Worry. Worry was assessed in relation to (1) another attack like the WTC, (2) anyone close being armed by Anthrax or bioterrorism, (3) a family member losing her/his job, (4) not being safe because of race/religious belief. Items on a 0-2 scale (0=*not at all*, 1=*somewhat*, 2=*a lot*) were summed to obtain a total score (0-8).

2.3. Family Environment: As with the individual level data, several family level variables were collected in the original study (e.g., paternal education, child monitoring) were measured.

2.4. Neighborhood Level Measures. Thirty-eight items were obtained from the US Census (2000) and the NYC Department of City planning. Using PCA techniques, consistent with Musa (2013)[17], Kriger et al [73-76], measures of SES, and neighborhood safety and quality were computed. We utilized a composite index of neighborhood SES calculated from population measures obtained from the U.S. Census American FactFinder website (U.S. Census Bureau) at the zip code level, following the methodology developed by Krieger and colleagues[73,75,77] and were computed by standardizing and summing the following variables: % non-white persons, % households with public assistance, % single parent households, % persons living below poverty, % unemployment, % annual income below $30,000, and % persons without least a high school diploma[17]. The neighborhood quality and safety indices were also be computed using GIScience techniques from variables obtained from the NYC My Neighborhood Statistics website and will include measures (http://gis.nyc.gov/ops/mmr/address.jsp?app=MMR), of neighborhood deterioration (disorderly youth complaints, derelict vehicles, rodents, noise, air quality, etc.) as well as crime and fire statistics (robbery, felonious assault, major felony, etc)[17]. Since these data are only available at the NYPD Precinct and/or NYC Fire District levels, the data was disaggregated to the Census Block level using GIScience dasymetric mapping methods[78-83] and re-aggregated to the zip code, which improves the specificity of the index. Dichotomous neighborhood-level variables indicating high neighborhood SES, quality, and safety (above the 50th percentile for New York City zip codes) were created by splitting each index at its median.

3. Results

3.1. Psychopathology Factor Structure among Hispanic Students:

Preliminary chi-square tests were conducted to compare racial/ethnic differences in socio-demographic characteristics (i.e., population density, insurance, household income, etc.). Chi-square tests were also conducted to examine racial/ethnic differences in prevalence of prevalence of mental health disorders using traditional DSM classifications. These included; posttraumatic stress, major depression, generalized anxiety, anxiety, separation anxiety, panic, agoraphobia, conduct disorder, and substance use disorders.

The main analysis included an exploratory factor analysis to determine the factor structure of mental health symptom profiles of Latino children exposed to trauma. Factor analyses were performed using Mplus software for weighted observations. The analysis was performed using a Promax rotation. The chi square test of association, RMSEA (Root Mean Square Error of Approximation), Root Mean Square Residual, eigenvalues, and rotated component matrix where examined for the following symptoms: post-traumatic stress, major depression, generalized anxiety, separation

anxiety, panic, agoraphobia, conduct disorder, and substance use. The EFA was performed for the full sample of Latino children (N=2,936) and by nativity; US Born Latinos (n= 1,682) and Foreign Born Latinos (n= 710).

Analysis revealed Hispanic youth were less likely to have mothers who completed high-school level of education, to live with both parents and to have been exposed to 911 attacks through TV exposure compared to non-Hispanic White youth. There were no differences between US-born Hispanic youth relative to their foreign-born counterparts.

With respect to prevalence of mental health disorders, over 11% of both Latino and White youth had generalized anxiety and conduct disorder. 12% of Hispanic youth had PTSD compared to 8% of White youth, which approached, but did not reach significance, p = .067. Latino youth were significantly more likely to report agoraphobia (17%) and separation anxiety (14%) compared to White youth (10% and 9% respectively).

Factor Analysis. The factorability of the 53 symptom items related to post traumatic stress, major depression, generalized anxiety, separation anxiety, panic, agoraphobia, conduct disorder, and substance use was examined. Ten factors were identified based on Kaiser's criterion of eigenvalues greater than 1.00. Solutions for six to 10 factors were each tested using promax rotations of the factor loading matrix. The EFA was conducted for the full sample and subsequently for U.S. born Hispanics and Foreign born Hispanics separately. We compared the models for the full sample using fit statistics and found the six factor solution had the best fit, RMSEA (1, *N* 2,936) .012, p .00, RMSR (1, N 2,936) .045, p .00 and was the most interpretable.

One item, "Have you skipped school?", was eliminated because it did not meet the minimum criteria of a primary factor loading of.3 or above. According to Worthington and Whittaker (2006), the EFA was repeated due to the item deletion.

The final six factor EFA was conducted with 52 items solution. Two items did not meet the minimum criteria of a primary factor loading of.3 or above. However, given the exploratory nature of these analysis, the two items were not removed as these had factor loadings of .3 or above in the models for U.S. born Hispanics and/or foreign-born Hispanics. The items were "Have you often wanted to stay at home and not go to school of other places without your mother or father?" and "Have you often worried a lot before you were going to play a sport or game or do some other activity?" The final identified factors are: (1) avoidance/fear of parental-separation; (2) alcohol/substance abuse without familial problems; (3) conduct disorder (interpersonal?); (4) somatization; (5) sleep problems; and, (6) loss of enjoyment (I'm moody).

3.2. Panic Disorder:

Analyses were limited to students in grades 6-12. Prevalence of probable panic disorder was tabulated by sociodemographic factors (gender, age group, race/ethnicity, maternal education, and living with both biological parents) and exposures (level of 9/11 exposure, high media exposure, attending a ground zero area school, and prior trauma). The association of each sociodemographic and exposure variable with probable panic disorder was tested with a Chi-squared test. The unadjusted and mutually adjusted magnitudes of association of each sociodemographic and exposure variable with probable panic disorder were then estimated using logistic regression analysis. Finally, the prevalence of other probable psychiatric disorders (PTSD, MDD, GAD, separation anxiety, agoraphobia, conduct disorder, and alcohol abuse/dependence) were tabulated among those with and without probable panic disorder. The respective association of probable panic disorder with each of the other probable disorders was tested using logistic regression, in unadjusted models, models adjusted for sociodemographic factors only, and models adjusted for both sociodemographic factors and exposures. Interaction terms between probable panic disorder and each exposure variable (level of 9/11 exposure, media exposure, attending a ground zero area school, and prior trauma) were tested, and stratified odds ratios were examined if the interaction term was significant. All descriptive statistics and statistical analyses were conducted in SUDAAN version 11.0.1, taking into account the sampling strategy (strata, clustering, joint probability of selection, sampling weights, and the subpopulation of the current analysis).

The proportion of the weighted sample in school grades 6-8 was 45.1%, and in grades 9-12 54.9%. The sex and race/ethnic distribution was comparable to NYC public school population at the time of the survey. The proportion of the weighted sample with severe, moderate and mild level of 9/11 exposure was 28.2%, 34.5%, and 37.3% respectively. Only 1.5% of the weighted sample attended a Ground Zero Area school; 67.1% of the sample had high media exposure to the event.

Predictors of probable panic disorder. Among 6991 students in the analytic sample, 522 (8.0%) had probable panic disorder. Probable panic disorder was significantly more prevalent among those with more severe levels of 9/11 exposure (11.4% among severely exposed, 8.4% among moderately exposed, and 5.0% among mildly exposed, p=0.0052), those with high media exposure (9.1% vs. 5.7%, p=0.0128), and those reporting prior trauma (12.8% vs. 5.6%, p=0.0001). Gender was also associated with probable panic disorder, with females having a higher prevalence than males (10.3% vs. 5.4%, p=0.0010); however, other demographic characteristics (age, race/ethnicity) and social characteristics (maternal education level, living with both biological parents) were not.

After adjusting for sociodemographic factors and exposures simultaneously, moderate 9/11 exposure was no longer associated with probable panic disorder. Severe 9/11 exposure (AOR=2.02, 95% CI (1.11, 3.69)), high media exposure (AOR=1.54, 95% CI (1.03, 2.29)) and prior trauma (AOR=2.36, 95% CI (1.61, 3.45)) were associated with

increased odds of panic in the adjusted models. Being female also remained significantly associated with increased likelihood of panic (AOR=1.96, 95% CI (1.31, 2.92)).

Probable panic disorder and comorbid psychiatric disorders. With the exception of alcohol abuse/dependence, probable panic disorder was associated with a significantly increased likelihood of all mental disorders assessed. The associations remained statistically significant after adjusting for sociodemographic factors and exposures. Panic had the strongest associations with GAD and separation anxiety, followed by PTSD, major depression, and agoraphobia.

Significant interaction terms ($p<0.05$) between probable panic disorder and exposure variables were found only for separation anxiety and attending a ground zero area school ($p=0.0054$) and alcohol abuse/dependence and attending a ground zero area school (GZA) ($p=0.0183$). Separation anxiety was associated with increased risk of probable panic disorder among both GZA and non-GZA students; however, the association was stronger among GZA students. Alcohol abuse/dependence was associated with panic among GZA students, but not among non-GZA students. All other interaction terms between probable panic disorder and exposure variables were non-significant, indicating that levels of comorbidity between panic and other probable disorders (PTSD, MDD, GAD, separation anxiety, agoraphobia, conduct disorder, and alcohol abuse/dependence) did not vary by level of 9/11 exposure, high media exposure, attending a ground zero school (except for separation and alcohol), or prior trauma status.

3.3. Latent Class Structures of Psychopathological Symptoms:

Latent Class Analysis (LCA), performed using the poLCA function in the R package poLCA [10], probabilistically groups each observation into a latent class, identifying and characterizing classes of cases with similar symptom profiles. LCA models were fit starting with a two-class model, and up to six classes. The Bayesian Information Criterion (BIC) was used to select the best fitting model as the model with the lowest BIC value. First, LCA was applied to the eight PTSD items in the whole sample of 6,733 trauma-exposed individuals. Second, to investigate the relationship between PTSD symptoms profiles and functional impairment, LCA was simultaneously applied to the eight PTSD items and the seven impairment indicators; in each class derived from this analysis we also examined the prevalence of MDD, SAD and CD. Third, LCA models were evaluated separately in four demographic groups: males (N=1879) and females in 4-8 grades (N=2258), and males (N=1999) and females in 9-12 grades (N=2017). Fourth, LCA was applied to 13 exposure variables (described above), to empirically identify profiles of trauma-exposure, as in previous studies (e.g., [11, 12]); LCA models of PTSD were then fitted within each trauma-exposure class.

We evaluated quantitative differences among classes (i.e., differences in the level of severity of symptom profiles) by calculating the sum of the conditional probability of each symptom within a class. To investigate qualitative differences among

classes and across groups defined by age and gender, and by exposure (i.e., configurational differences in the relative prevalence of symptoms), we calculated, for each symptom, the relative risk (RR) of endorsing the symptom in one class compared to another class (e.g., severe vs. intermediate disturbance), and, within each disturbance class (e.g., severe disturbance), in one group compared to another one (e.g., younger girls vs. younger boys). To focus on larger differences between classes, we considered only RR ≥2, a cutoff based on common rule of thumb in the field of epidemiology. The data set used for this study had no missing data. Missing data were imputed from other data (items on scales, write-ins, demographics, or school variables) or by using multiple imputations in the case of sex, maternal education, family composition, and probable psychiatric disorders, using an approach described in Hoven [3].

BIC values for three-, four-, and five-class models were, respectively, 59775, 59509, and 59521; therefore, a four-class model was selected as the best fitting. The classes define different profiles of symptom severity characterized by progressive increase of symptom load and prevalence of PTSD and impairment from class 1 to 4. Class 1 (50% of subjects) was characterized by little disturbance, showing a low probability of symptom endorsement, with the exception of recurrent thoughts. Prevalence of PTSD and impairment was 0% and 17.2%, respectively. Members of class 2 and 3 (23% and 17% of subjects, respectively) exhibited intermediate disturbance, with an average of 3.2 and 2.9 symptoms, respectively. Configurational differences between the two intermediate disturbance classes consisted of a higher probability (RR≥2) of endorsing sleep-related symptoms (nightmares: RR=4.22, 95% CI=3.48-5.12; trouble sleeping: RR=6.00, 95% CI=5.03-7.16; all $p<0.0001$) in class 2 ("Sleep problems class"), and higher probability of reporting avoidance of activities, places (RR=6.63, 95% CI=5.20-8.46, $p<0.0001$) and people (RR=11.41, 95% CI=8.10-16.07, $p<0.0001$) in class 3 ("Avoidance class"). Class 2, compared to class 3, had slightly higher prevalence of PTSD (14.0% vs. 8.6%; RR=1.62, 95% CI=1.28-2.04, $p<0.0001$) and impairment (32.6% vs. 28.2%; RR=1.15, 95% CI=1.02-1.31, $p=0.0232$). Class 4 (10% of subjects) was qualified by severe disturbance (over 5.9 symptoms, on average); prevalence of PTSD and impairment was 99.6% and 46.6%, respectively. The severe disturbance class had higher RR (all $p<0.0001$) of reporting avoidance of activities, places (RR=12.67, 95% CI=10.00-16.05) and people (RR=19.65, 95% CI=14.00-27.57), compared to the sleep problems class, nightmares (RR=7.53, 95% CI=6.25-9.09), trouble sleeping (2.12, 95% CI=1.84-2.43), and concentration problems (RR=2.55, 95% CI=2.33-2.80), compared to the avoidance class, and foreshortened future, compared to both the intermediate severity avoidance class (RR=2.12, 95% CI=1.84-2.43) and sleep problems class (RR =2.27, 95% CI=1.97-2.61).

Individual profiles of PTSD symptoms and functional impairment indicators. A five-class model best fitted the data. The largest drop in BIC values was observed increasing the number of classes from 2 (=77756) to 5 (=76467). Increasing the number of classes up to 6 was further reducing the BIC value (=76427), but at the expense of parsimony. The low disturbance class, the two classes of intermediate disturbance, and the severe disturbance class previously shown could still be identified. Among these

classes, only the severe disturbance class had high levels of PTSD (6.04 symptoms, on average; prevalence=98.0%) and impairment (2.12 impairment indicators, on average; prevalence=66.4%). In the intermediate avoidance class, intermediate sleep problems class, and no disturbance class, prevalence of PTSD was 10.6%, 28.6%, and 0.0%, respectively; prevalence of impairment was 21.6%, 15.1%, and 6.7%. The inclusion of impairment variables generated a fifth class with low PTSD severity (2.19 symptoms, on average; prevalence=0.7%) and high level of impairment (2.57 impairment indicators, on average; prevalence=97.7%). Compared to the severe PTSD disturbance class, the high degree of impairment and low PTSD disturbance in the fifth class might be, in part, explained by the high prevalence of CD (32% vs. 20%, RR=1.67, 95% CI=1.36-2.04, $p<0.0001$). In contrast to the fifth class, the severe PTSD disturbance class had instead higher rates of MDD (32% vs. 25%; RR=1.27, 95% CI=1.06-1.52, $p=0.0081$) and especially SAD (56% vs 19%; RR=3.00, 95% CI=2.52-3.57, $p<0.0001$).

PTSD symptom profiles in groups defined by gender and age: BIC values for three-four-, and five-class models were, respectively, 18088, 18056, and 18098 in younger girls, 14139, 14124, and 14156 in younger boys, 14524, 14482, and 14516 in older girls, 12102, 12097, and 12133 in older boys. Thus, in each demographic group, a four-class model had the lowest BIC values, and was selected as the best fitting. Despite differences in the prevalence of PTSD across groups in the entire epidemiological sample (younger girls: 21%; younger boys: 14%; older girls: 10%; older boys: 5%), PTSD symptom profiles within each disturbance class were in general similar across demographic groups. At severe PTSD levels, RR≥2 was observed only when comparing the probability of endorsing avoidance of activities between older girls and older boys (RR=2.07, 95% CI=1.66-2.58, $p<0.0001$). Within the intermediate disturbance class characterized by sleep-related symptoms, every group had a higher probability of reporting nightmares compared to older boys (older girls: RR=3.44, 95% CI=2.54-4.66; younger boys: RR=3.40, 95% CI=2.51-4.62; younger girls: RR=2.80, 95% CI=2.07-3.80; all $p<0.0001$). In each demographic subgroup, prevalence of PTSD and impairment, respectively, were always above 90% and 43% in the severe disturbance class, below 21% and 37% in the intermediate disturbance classes, and 0% and below 19% in the low disturbance class.

PTSD symptom profiles in groups defined by empirically-derived classes of exposure. When LCA was applied to items assessing direct, indirect and media exposure to 9/11, the steepest drop in BIC values was observed when the number of classes was increased from 2 (=88151) to 4 (=86069); increasing the number of classes up to 5 produced only a marginally lower BIC value (=85872) at the expense of a complication in the model. Thus, based on principles of parsimony and interpretability, a 4-class solution was accepted as the best fitting model. Class 1 (N=1655; females=47%; younger age range=15%) grouped individuals with high probability of having experienced direct exposure events ("direct exposure" class). Class 2 (N=2963; females=52%; younger age range=55%) was characterized by high probabilities of exposure through the media ("media exposure" class). Class 3 (N=696; females=59%; younger age range=48%) was representative of individuals with intermediate probabilities of having experienced direct exposure events, and high probability of

reporting indirect exposure, and exposure through the media ("indirect/media exposure" class). To better examine exposure-related differences in the latent structure of PTSD, these 3 classes were the focus of analysis, since a fourth class (N=1419; females=59%; younger age range=56.3%) was characterized by low or intermediate probabilities of reporting exposure events. The prevalence of PTSD was higher in the indirect/media exposure class (29%), compared to the media and direct exposure classes (13% and 9%, respectively).

BIC values for three-, four-, and five-class models were, respectively, 17929, 17927, and 17950 in the direct exposure group, and 9344, 9333, and 9397 in the indirect/media exposure group. In the media exposure class, the largest drop in BIC values was observed increasing the number of classes from 2 (=33545) to 4 (=33170); increasing the number of classes up to 5 produced only a marginal increase in BIC value (33157), and further increasing the number of classes deteriorated the model's fit. Thus, a four-class model was selected as the best fitting model in each exposure class. Within each exposure class, PTSD profiles were overall consistent with those identified in the whole sample. Configurational differences across severe disturbance classes were in general negligible. Among intermediate disturbance classes characterized by avoidance symptoms, the probability of endorsing nightmares was much higher in the indirect/media exposure class, compared to the media (RR=5.09, 95% CI=3.43-7.57, $p<0.0001$) and direct exposure (RR=14.29, 95% CI=4.53-45.05, $p<0.0001$) classes. No differences were observed between the media and direct exposure classes. Finally, among intermediate classes defined by sleep-related problems, the probability of endorsing nightmares and trouble sleeping was higher in the indirect/media exposure class compared to the media exposure class and to the direct exposure class, while the probability of endorsing avoidance of thoughts was higher in indirect/media exposure class compared to the direct exposure class on the probability of endorsing avoidance of thoughts (RR ranged between 2.07 and 3.18, all $p<0.0001$). In each exposure class, prevalence of PTSD and impairment, respectively, were always above 88% and 44% in the severe disturbance class, below 41% and 39% in the intermediate disturbance classes, and 0% and below 25% in the low disturbance class.

3.4. Grief:

Risk factors associated with grief, PTSD, and MDD. In a first set of multivariate regressions we assessed the relationship between grief, PTSD, and MDD and (a) loss and indirect 9/11 exposure (9 variables), (b) direct 9/11 exposure (4 variables), (c) media exposure to 9/11 (2 variables), and (d) previous exposure (2 variables). In a second set of multivariate regressions – for each psychiatric outcome – items that were at least marginally significant ($p<.1$) at step 1 were jointly included in multivariate regression models. In step 2, each outcome was examined with models that were both adjusted and unadjusted for the other two outcomes.

Every regression model was adjusted for demographic variables (gender, age group, and race).

Incremental validity of grief. We examined the association of Grief, PTSD and MDD with impairment and the other negative outcomes. Demographic variables were included in every regression. To account for clustering of the data due to sampling design [6], analyses were implemented in SUDAAN release 11.0.1 Version 8 [13].

Factor analysis. Factor analysis of Grief, MDD, and PTSD symptoms in 1,696 bereaved youth was implemented with the R package *psych*, with "promax" oblique transformation of the solution [14]. Parallel analysis in *psych* was used to determine the number of factors to retain [14-17]. Parallel analysis in *psych* retains only eigenvalues of the real data that are superior or equal to the average of eigenvalues of random samples from the real data as well as normally distributed random data with the same number of subjects and values [14].

Latent class analysis. LCA probabilistically groups each observation into a latent class, without any a priori assumption about the nature of the latent categorization, identifying and characterizing clusters of cases with similar symptom profiles. LCA was performed using the poLCA function implemented in the R package poLCA [10, 18, 19]. The LCA models were fit starting with a two-class model, increasing the number of classes up to six. LCA was applied to the 5 grief items, the 8 PTSD items and 9 MDD items in a sub-sample of 1,696 subjects who experienced the death of a family member and/or a friend.

We also examined the relationship between identified classes and impairment and other negative outcomes, using the class with the lowest probability of symptom endorsement as the reference class. Finally, five separate models in SUDAAN were run to examine whether (1) demographics, (2) loss-related variables, (3) indirect exposure, (4) direct exposure, and (5) media exposure increased the likelihood of class membership, compared to the class with the lowest probability of symptom endorsement. Models 2-5 were adjusted for demographic variables.

Multivariate regressions. Grief was more likely in the younger age group, and was strongly associated with all loss-related variables, also after adjusting for PTSD and MDD. Knowing that a family member was in the WTC area and escaped unhurt was also associated with grief, both in adjusted and unadjusted models. Adjusting for PTSD and MDD, exposure through radio, newspaper, or magazines was only marginally associated with Grief. PTSD was significantly associated with Grief. The association between MDD and Grief was only marginally significant. Very similar results were obtained using a more severe definition of grief (≥3 symptoms) and symptom count (data not shown).

PTSD was more likely in females and younger youth, and – in models unadjusted for Grief and MDD – it was associated with loss of a family member, and with variables related to indirect, direct variables and media exposure to 9/11. However, adjusting for grief and MDD, only direct exposure variables (i.e., seeing the planes and being hurt in the attack) were still significantly associated with PTSD. Grief and especially MDD were strongly associated with PTSD.

MDD was more likely in females and older participants. Most media exposure variables and knowing someone who was in the WTC area and escaped unhurt were associated with MDD in models unadjusted for Grief and PTSD; in adjusted models, only the latter variable remained significant. MDD risk was higher in youth positive for Grief and, in particular, PTSD.

Incremental Validity of Grief. Adjusting for PTSD and MDD, Grief marginally increased the odds of reporting any new health problem since 9/11, and was significantly associated with a higher likelihood of endorsing criteria for functional impairment, and a higher impairment score. The endorsement of at least one new health problem, the number of new health problems reported, and a worse worry score were particularly likely in youth positive for PTSD. MDD was also significantly associated with these three outcomes, to a lesser degree. PTSD and especially MDD were strongly associated with avoidant copying style, and with both impairment-related outcomes. The positive outlook score was significantly higher in association with Grief and PTSD, and lower in relationship to MDD. Models including a more severe definition of grief and Grief symptom count yielded substantially similar results (data not shown); however, the two grief-related outcomes were marginally associated with the likelihood or endorsing criteria for functional impairment.

Factor analysis. Parallel analysis suggested that the number of factors equals 6. The 6 factors solution has good fit statistics (root mean square residual-RMSR=.016, df corrected SRMR= .022; BIC= -615; Tucker Lewis Index-TLI= .971; root mean square error of approximation-RMSEA / 90% C.I. = .025/ .02-.029).

The factors were ordered by their eigenvalues, with higher eigenvalues first. Factor 1 has strong loadings on grief symptoms, and explains the largest proportion of variance. Factor 2 and 3 represent common variance underlying cognitive/emotional and physical MDD symptoms, respectively. Factor 4 and 5 load on PTSD symptoms related to alterations in arousal/reactivity (factor 4) and to avoidance (factor 5); sense of foreshortened future also loads on factor 5. Finally, recurrent thoughts of the WTC attack had a week loading on factor 6, and explained very little variance. The strongest and weakest correlation of Factor 1, underlying Grief symptoms, was – respectively – with factor 5 (PTSD symptoms of avoidance and foreshortened future) and factor 3 (physical MDD symptoms).

Latent class analysis (LCA). The lowest BIC value was obtained with a 6-class model (BIC= 36,737; AIC=35,993). However, an 8-class model with a lower AIC value (=35,806) and a slightly higher (=36,801) identified a small class (4.0% of subjects) defined mainly by high probability of reporting grief symptoms. Since sensitivity was favored over specificity, in order to select a model that could describe the heterogeneity in the population and capture small but clinically meaningful classes (as in this case), AIC was preferred over BIC. Furthermore, the selected 8-class model contained only two additional classes compared to the most parsimonious 6-class model, below the a priori specified limit of xx additional classes compared to the BIC-favored model (see Methods section).

Four classes where characterized by severe disturbance. A *severe grief class* (GRIEF; 3.7% of subjects) had mainly high probabilities of reporting grief symptoms (mean= 0.76), and moderate/low probabilities of reporting PTSD and MDD symptoms (mean= 0.46 and 0.25, respectively). A *severe PTSD and MDD class* (PTSD/MDD; 9.0% of subjects) had high probabilities of PTSD and MDD symptoms (mean= 0.66 and 0.73, respectively), and very low probabilities of grief symptoms (mean= 0.07). Subjects in the *severe MDD class* (MDD; 19.8% of subjects) showed high probability of endorsing MDD symptoms (mean= 0.75), and low probabilities of reporting Grief and PTSD symptoms (mean= 0.02 and 0.29, respectively). Finally, the *severe multimorbid class* (MULTIMORBID; 7.0% of subjects) was defined by high probability of Grief, PTSD, and MDD symptoms (mean= 0.78, 0.77, and 0.76, respectively).

Three classes were defined by moderate and low severity. In the *moderate PTSD and MDD class* (Mod-PTSD/MDD; 14.6% of subjects), youth had very low probabilities of reporting Grief symptoms (mean= 0.13) and moderate probabilities of PTSD and MDD symptoms (mean= 0.44 and 0.29, respectively). The *moderate MDD class* (Mod-MDD; 8.3% of subjects) was characterized by low probabilities of Grief and PTSD symptoms (mean= 0.39 and 0.37, respectively), and moderate probabilities of MDD symptoms (mean= 0.60). The *low MDD class* (Low-MDD; 21.9% of subjects) had low probabilities of MDD symptoms (mean= 0.35) and very low probabilities of Grief and PTSD symptoms (mean= 0.01 and 0.16, respectively).

Finally, subjects in the *no disturbance class* (No-DIST; 15.7% of subjects) showed very low probabilities of endorsing Grief, PTSD, and MDD symptoms (mean= 0.01, 0.13, and 0.05, respectively).

Compared to the No-DIST class, the GRIEF class was significantly associated with the onset of any new health problem since 9/11, with presence of impairment, and with a higher impairment score (data not shown). Among all classes, the MULTIMORBID class showed the strongest association with all negative outcomes, followed by the PTSD/MDD class (data not shown). Younger age and having a friend hurt in the attack significantly increased the likelihood of belonging to the GRIEF class. Death of a family member and death of a fiend were only marginally associated with GRIEF class membership. The odds of belonging to the MULTIMORBID class were higher in participants who were of female gender, younger age and Hispanic race. Knowing a friend hurt in the attack, death of a family member, death of a friend and most media-exposure variables were also associated with this class. Regarding the remaining classes, female gender increased the likelihood of belonging to the PTSD/MDD and MDD class; younger age was associated with the Low-PTSD/MDD class. Hispanic and Mixed/Other races were more likely in the Low-PTSD/MDD and Mod-MDD classes, respectively. Finally, death of a friend and exposure to 9/11 through Radio, newspaper, or magazines was associated with higher odds of belonging – respectively – to the Mod-MDD and Low-MDD classes.

3.5. Comorbidity:

When LCA was applied to 48 symptoms across 7 disorders, the largest drop in AIC and BIC values was observed increasing the number of classes from 1 to 8. Furthermore, compared to a 7-class solution, an 8-class solution identified 4 severe classes, characterized by high probabilities of reporting different combinations of symptoms, in association with a relatively large decrease in AIC (-825) and BIC (-481) values, indicative of a substantial increase in fit. Compared to the 8-class solution, the 9-class solution produced a more marginal decrease in AIC (-499) and BIC (-155) values, and yielded the same 4 severe classes, adding one intermediate severity class. Therefore, based on parsimony and interpretability (see Material and Methods), the 8-class solution was selected as the final model.

Four classes where characterized by severe disturbance. A *severe internalizing class* (INT; 5.9% of subjects) had high probabilities of internalizing symptoms (mean=71.3%), and low probabilities of CD symptoms (mean=16.0%). A *severe MDD class* (MDD; 14.3% of subjects) had high probabilities of MDD symptoms (mean=69.7%), and lower probabilities of symptoms of PTSD/anxiety disorders (mean=37.5%), and CD (mean=17.1%). Two severe classes showed the highest probabilities of endorsing externalizing symptoms. In the *severe externalizing class* (EXT; 6.6% of subjects), probabilities of CD symptoms were high (mean=50.4%, excluding being cruel to/hurt animals, run away from home, and expelled from school), while probabilities of MDD symptoms (mean=40.1%) and symptoms of PTSD/anxiety disorders (mean=17.0%) were lower. The *severe distress/externalizing class* (Distress/EXT; 6.0% of subjects) showed high probability of CD symptoms (mean=50.7%), in combination with MDD (mean=78.6%) and GAD symptoms (mean=59.7%). Three classes were defined by low to moderate severity. The *moderate disturbance internalizing class* (Mod-INT; 12.2% of subjects) and *low disturbance internalizing class* (Low-INT; 18.3% of subjects) had, respectively, moderate and low probabilities of internalizing symptoms (mean=45.5% and 23.1%, respectively), and low probabilities of CD symptoms (mean=12.0% and 7.5%, respectively). A *moderate disturbance MDD class* (Mod-MDD; 16.6% of subjects) had moderate probabilities of symptoms of MDD (mean=39.4%), and low probabilities of symptoms of PTSD/anxiety disorders and CD (mean=10.2% and 12.3%, respectively). Finally, a *no disturbance class* (No-DIST; 20.1% of subjects) was characterized by negligible probabilities of symptoms endorsement (mean=6.2%).

Focusing on the No-DIST class and the four severe disturbance classes, we examined whether age, gender, race/ethnicity, and three types of exposure to 9/11 predicted class membership, and whether classes differed in terms of prevalence of impairment,

First, the No-DIST class (reference) was compared to the severe disturbance classes. The three types of exposure to the WTC attack increased the likelihood of belonging to all severe classes, with the exception of a non-significant association between direct exposure and the EXT class. In addition, compared to their respective

reference group (see Methods), the probability of belonging to the INT class was higher in 8-11 years old (y/o) girls and in Hispanic/Latino youth, and lower in older (12-14 and 15-21 y/o) males. MDD class membership was more probable in 12-14 y/o girls and older participants (15-21) of both gender, and in association with Asian and Mixed race/ethnicity. Older girls (12-14 and 15-21 y/o), and youth of Hispanic/Latino and Mixed race/ethnicity were more likely to belong to the Distress/EXT class. Finally, the probability of belonging to the EXT class was lower in 8-11 and 15-21 y/o old females, and more likely in participant of mixed race/ethnicity. Impairment was strongly associated with the severe classes, INT and Distress/EXT in particular.

Second, the INT class (reference) was compared to the other three severe disturbance classes. Compared to 8-11 y/o males (reference group), older participants (12-14 and 15-21 y/o) across genders showed higher odds of belonging to the MDD and Distress/EXT class; the two older age groups of males had also a higher probability of belonging to the EXT class. MDD class membership was also associated with Asian race/ethnicity. Young girls, Hispanic/Latino youth, and – in general – participants exposed to the WTC attack had a lower chance of belonging to the MDD, Distress/EXT and EXT classes. Risk of impairment was lower in the MDD and EXT classes.

Third, the Distress/EXT class (reference) was compared to the MDD and EXT classes. Older youth (15-21 y/o), regardless of gender, were more likely to belong to the MDD class. Probability of belonging to the EXT class was lower in association with female gender, across all age groups. Direct and media exposure, and family exposure, were less likely in the MDD and EXT class, respectively. Youth in the MDD and EXT classes had lower odds of being impaired.

Fourth, the EXT class (reference) was compared to the MDD class. Youth of female gender, in each age group, 15-21 y/o males, Asian youth and participants exposed to 9/11 either directly or through the media were more likely to belong to the MDD class. The EXT and MDD class did not differ in terms of impairment.

3.6. PTSD, Neighborhood, Family, and Race/Ethnicity:

The neighborhood SES, quality, and safety indices displayed excellent or good internal consistency (Cronbach's alpha 0.90, 0.87, and 0.96 respectively). The three neighborhood indices were moderately to highly correlated with one another, and the correlation coefficients were statistically significant.

The GZA school sample consisted of 2,030 students living in 164 zip codes. The sample rate of probable PTSD diagnosis was 7.0% and the mean number of PTSD symptoms was 1.89 (SD=1.70). The sample was 49.4% female with a mean age of 15.18 years (SD=1.99), and 20.9% were non-Hispanic white. Asians were the largest racial/ethnic group, constituting 41.9% of the sample. Rates of direct exposure and media exposure were high (83.2% and 63.3% respectively), while rates of family exposure and previous exposure were lower (8.3% and 23.3% respectively). 29.9% of the sample lived in high-SES neighborhoods, 21.5% lived in high-quality

neighborhoods, and 17.7% lived in high-safety neighborhoods. 10.8% of the sample lived in neighborhoods categorized as high-SES, high-quality, and high-safety.

Four Hierarchical Linear Models (HLM's) were performed of the PTSD Symptom counts (PTSD Sy). In the model testing only individual-level sociodemographic and exposure variables as predictors (Model 1), being female, younger, African-American or Hispanic (compared to whites), family exposure, previous exposure, and media exposure were significantly associated with higher levels of PTSD symptoms (all $p<0.05$). Direct exposure was associated with PTSD Sy at a trend level ($p=0.0546$). Being Asian or other/mixed race/ethnicity (compared to whites), low maternal education, and not living with both parents were not associated with PTSD Sy. In the models testing the respective association of each neighborhood-level characteristic with PTSD Sy, adjusting for all individual-level factors (Models 2-4), high neighborhood SES and high neighborhood quality were independently associated with lower levels of PTSD symptoms (Beta=-0.31, SE=0.09, $p=0.0005$ and Beta=-0.20, SE=0.09, $p=0.0266$). High neighborhood safety was not associated with PTSD Sy (Beta=-0.14, SE=0.10, $p=0.1614$). In the final model of PTSD Sy (Model 5), both neighborhood SES and neighborhood quality were entered as predictors, adjusting for all individual-level factors. Living in a high-SES neighborhood remained associated with 0.28 fewer PTSD symptoms on average, compared to living in a low-SES neighborhood (Beta=-0.28, SE=0.09, $p=0.0029$). Neighborhood quality was no longer significantly associated with PTSD Sy when adjusting for neighborhood SES.

Four additional HLMs were created for the PTSD Disorder (PTSD Dx) outcome. In the model testing only individual-level sociodemographic and exposure variables as predictors (Model 6), being female, younger, and Hispanic (compared to whites), previous exposure, and media exposure were significant risk factors for PTSD (all $p<0.05$). Being African-American, Asian, or other/mixed race/ethnicity (compared to whites), low maternal education, not living with both parents, direct exposure, and family exposure were not associated with PTSD Dx. In the models testing the respective association of each neighborhood-level characteristic with PTSD Dx, adjusting for all individual-level factors (Models 7-9), high neighborhood SES and high neighborhood quality were independently protective against PTSD (AOR=0.61, 95% CI (0.38, 0.99) and AOR=0.56, 95% CI (0.33, 0.97). Thus, living in a low-SES rather than high-SES neighborhood is associated with 1.64 times greater odds of PTSD, and living in a low-quality rather than high-quality neighborhood is associated with 1.79 times greater odds of PTSD, adjusting for individual-level factors (to ease the interpretation of findings, the reciprocals of the AOR's were calculated). High neighborhood safety was not associated with PTSD Dx (AOR=0.81, 95% CI (0.48, 1.36). In the final model of PTSD Dx (Model 10), both neighborhood SES and neighborhood quality were entered as predictors, adjusting for all individual-level factors. Neither neighborhood SES nor neighborhood quality remained significantly associated with PTSD Dx when adjusting for one another, perhaps due to multicollinearity.

4. Discussion

This study used a multilevel approach to assess the effects of neighborhood context on PTSD risk among children and adolescents living in NYC at the time of the 9/11 attacks. By incorporating a variety of neighborhood measures, we were able to develop, for the first time, a relatively comprehensive picture of how children's stress reactions to 9/11 were influenced by the contexts they inhabit as they experience, process, and cope with stressful life events.

Consistent with prior literature, neighborhood SES was independently predictive of PTSD symptoms, even after controlling for individual characteristics and neighborhood quality. Further research is needed to better understand the mechanisms by which this type of neighborhood composition protected children from experiencing symptoms of traumatic stress following 9/11, and whether this effect holds true for other types of mass trauma. Low neighborhood SES and low quality neighborhood were significant predictors of probable PTSD diagnosis, but low neighborhood safety was not.

Despite being the second fastest growing ethnic group in the United States, Latinos continue to remain underrepresented both in mental health research and in service utilization. There is also insufficient attention to the diversity of the children exposed to trauma, and less so in consideration of within group differences.

The exploratory study examined role of ethnic group membership among Latino and White youth and considered the role of nativity in the manifestation of trauma related distress among Latino youth.

In general, we found over 11% of both Latino and White youth had generalized anxiety and conduct disorder after exposure to 9/11 WTC attack, underscoring the findings that youth exposed to traumatic events are a high-risk group. When we considered ethnic group differences, Latino youth were significantly more likely to report agoraphobia and separation anxiety compared to White youth. However, unlike previous research, however, that shows Latino populations have higher rates of PTSD symptoms compared to their Black or White counterparts[20-22], we did not find this trend among Latino youth. Although, Latino youth endorse more PTSD symptoms compared to White youth.

Despite the successes of the DSM series in improving diagnostic reliability, our study shows the core features of trauma-related disorders need to be unpacked. The results underscored the mental health symptoms of Latino youth expose to traumatic events do not nicely align with the current framework used to understand PTSD symptom structure. In this study, we found fear of parental separation, for example, was a unique experience among Latino youth consistent with the literature on familism and collectivist values in the Latino community. Latino youth also experienced somatic symptoms confirming research that documents some Latino groups may manifest psychological distress as physiological responses.

When considering within group differences related to place of birth, the framework to understand trauma became much less consistent with traditional DSM classifications. For less acculturated Latino youth, family problems did not result from substance abuse related problems compared to more acculturated Latino youth. This response contradicts what would be expected from literature on familism among less acculturated Latinos. Similarly, we found somatization to be a mental health response of US-born Latino youth, however, we did not see this trend among less acculturated youth. The literature, however, suggests somatic symptoms are a predominant manifestation of emotional distress among less acculturated Latino. Thus, further research is needed to develop a more robust framework to understand trauma related symptoms among Latinos youth.

Our results support the establishment of a new grief-related disorder: (1) precipitating events, (2) clinical correlates, (3) symptoms structure, and (4) phenomenology of grief are distinct from those of PTSD and MDD. It is important to highlight point 2: grief constitutes a clinically significant syndrome, associated with functional impairment independently of PTSD and MDD.

Importantly, bereaved individuals with severe grief reactions belong to two different classes, one with grief symptoms only (GRIEF class), one with grief symptoms co-occurring with MDD and PTSD symptoms (MULTIMORBID class). Youth with non-comorbid grief symptoms may benefit most from cognitive behavioral therapy focused on the grieving process; individuals in the multimorbid class symptoms may benefit most from eclectic therapy that targets a comorbid symptom profile.[23]

With regard to race/ethnicity, findings from the latent class analysis show that the odds of belonging to the severe MULTIMORBID class – defined by high probability of reporting Grief symptoms in combination with other internalizing PTSD and MDD symptoms – were higher in Hispanics/Latinos. In the aftermath of a disaster, Hispanic/Latino youth may be at elevated risk of developing complex multimorbid symptom profiles; intervention efforts should take this increased risk into account.

The present study is among the first to examine the association between exposure to a mass trauma and panic disorder in children. First, we found that both severe event exposure and high media exposure to 9/11 were associated with increased likelihood of probable panic disorder among school children in New York City six months after the event. Second, characteristics that conferred vulnerability to panic following the World Trade Center attack included sex and prior trauma, but not other demographic or family characteristics examined. Third, we found that panic was associated with significantly increased likelihood of a range of mental disorders, with two exceptions, levels of comorbidity between these disorders and probable panic did not vary by severity of exposure or media exposure. The pattern of comorbidity did vary among students attending ground-zero area schools compared to those attending schools outside this area. The association between panic and separation anxiety, and panic and alcohol abuse/dependence disorder was significantly different in GZA and

non-GZA students. Below we discuss findings in greater detail and their potential implications.

Before reviewing the findings of this study, however, it is important to note and keep in mind several methodologic limitations of this work. First, while the measure of panic is well validated, we can only be confident at the level of probable diagnosis. Second, in the absence of baseline assessment prior to 9/11, the link between exposure and subsequent mental health problems must be tempered; no causal conclusions can be drawn. Third, although we collected information on a wide range of correlates it is conceivable that there are factors contributing to the association we observed that the investigators are unable to adjust for.

The present study is one of the first reports demonstrating that recent trauma may be directly related to an increased likelihood of panic disorder in children. Previous studies have examined the relationship between early life traumatic events and the risk of panic attack and panic disorder in subsequent years[24-27]. While a few studies have examined peri-event panic (e.g., Pfefferbaum), panic attacks and disorder in the post-trauma period are neglected. Furthermore, the vast majority of studies looking at the links between traumatic experiences and panic have examined individual trauma experiences (i.e. child abuse and victimization), rather than exposure to a mass/community-based trauma event.

The effects observed in some measure mimic post-traumatic stress disorder: while severity of exposure was related to increased likelihood of panic outcomes, a dose response effect was not observed after adjustment. In addition, the significant impact of high media exposure was almost as strong. Similarly, panic disorder associated with mass trauma aligned with prior observations of panic in community samples. As predicted, history of trauma was associated with increased likelihood of panic following the World Trade Center attack. While this link has previously been noted among individuals with PTSD, these are the first data to show a link between a history of trauma and increased likelihood of panic in a representative sample of children. Gender differences, showing increased risk among females, are also consistent with previous epidemiologic studies. However, contrary to expectation, other demographic differences were not found.

The characteristic comorbidity of panic with a range of mental disorders was observed. The strongest link mental comorbid mental disorders were shown between panic and generalized anxiety disorder, followed panic and separation anxiety disorder, showing nine to ten-fold increased odds of each in the presence of panic. These associations were slightly attenuated after adjusting for different levels of exposure to trauma and comorbid mental disorders, yet after adjustment still remains strongly significant. In addition, panic was associated with over seven-fold increased likelihood of depression, and agoraphobia. Also, we found a link between panic and increased likelihood of conduct disorder. This finding is consistent to previous findings stating that there is an association between panic and disruptive behaviors among youth. In

contrast, we did not find any link between panic and alcohol abuse and dependence. This may, in part be attributed to the young age of the sample.

For the most part, comorbidity was equally common across exposure status, making the exceptions all the more remarkable. Although the proportion of children attending a ground zero area school was small, the disruption to their lives – returning to be reminded on a daily basis, or removal from their familiar school in a time of stress – may have been reflected in panic with comorbid separation anxiety, and panic with alcohol use. To fully understand the panic epiphenomenon surrounding mass trauma, longitudinal measurement of peri-trauma panic, and panic attacks and panic disorder in the aftermath of exposure is required over a longer period of follow-up.

The aggregation of psychiatric symptoms in the WTC-BOE study was assessed through LCA, which yielded 8 classes exhibiting distinctive comorbidity profiles, including four severe disturbance classes. This study, which sought to address some of the limitations of the LCA literature in youth in a representative sample of NYC students, is specifically relevant to improve understanding of comorbidity in childhood and adolescence.

First, demographic and exposure variables showed some degree of specificity in their prediction of class membership, consistent with findings suggesting that environmental experiences promote phenotypic differences [28]. For example, compared to the other severe classes, the probability of belonging to the INT class was especially high in young girls (8-11 y/o), Hispanics/Latinos, and in association with all three types of exposure to 9/11. In contrast, the probability of belonging to the MDD class was specifically elevated in older (15-21 y/o) males and females, and in Asian youth.

Second, the complex patterns of comorbidity observed in the WTC-BOE study highlight some of the limitations of etiopathogenic studies that neglect phenotypic complexity [29]. The marked heterogeneity of clinical manifestations, also related to psychiatric comorbidity, likely reflects heterogeneous pathophysiological processes, and constitutes one of the problems associated with the use of DSM nosology in research [30]. MDD provides a good example of the need to move beyond the examination of polythetic diagnoses. Even the largest GWAS mega-analysis of MDD was still underpowered to identify significant genetic variants: one possible explanation is that MDD might be characterized by higher clinical and etiological heterogeneity compared to other disorders, which decreases power to detect genetic effects [31]. Our results are consistent with these conclusions: youth with high probability of reporting MDD symptoms belong to three separate groups, suggesting that the distinct comorbidity patterns of MDD symptoms might contribute significantly to the clinical and etiological heterogeneity of MDD. The identification of more homogeneous MDD-related phenotypes could help detecting genetic variants achieving genome-wide statistical significance [31]. Another explanation could be related to the particular relevance of gene-environment interactions in the etiology and manifestation of MDD, indicating that genetic and environmental risk factors should be simultaneously examined to understand susceptibility to MDD [31]. In fact, the three classes manifesting severe MDD

are also characterized by different demographics and environmental risk factors. Thus, youth presenting with severe MDD syndrome in this sample actually belong to three separate comorbidity classes, wherein each class is characterized by demographic and environmental variables that are in part unique. These three critical sources of heterogeneity are often neglected in studies of the genetic and environmental precursors of psychiatric disorders.

Third, this study has several clinical implications. Compared to the two severe classes defined by high probability of reporting symptoms of only one disorder (i.e., MDD, EXT), youth in the INT and Distress/EXT classes show a high probability of endorsing symptoms of multiple disorders, and a higher likelihood of being positive for impairment. These findings support the use of interventions focusing on multi-morbidity and on the interplay between trauma-related, anxious, depressive and externalizing symptomatology, which may constitute a more evidence-based approach to prevention and treatment during childhood and adolescence [32-35]. The inclusion of comorbid symptomatology into clinical decisions may facilitate the allocation of youth to appropriate treatment groups [33]. In general, research on specific treatments for multimorbid syndromes has been ignored [35]; clinical trials should evaluate the effectiveness of disorder-specific versus transdiagnostic interventions, in which etiopathogenic processes and clinical features shared across conditions are addressed in treatments that may be useful for several disorders [36-41]. Furthermore, the association between class membership and demographic and exposure variables indicates important differences in vulnerability to psychopathology, and suggests that interventions may be improved by taking into account specific predictors of class membership [32]. Treatment models should also consider that intervening at critical periods of development in specific demographic groups may be particularly effective in delaying or preventing the progression to more severe and long-lasting psychopathology [32].

5 Conclusion:

Findings of this study have clear implications for both clinical work and future research concerning the associations between the long-term sequelae of exposure to trauma and psychopathology. From a clinical perspective, these data suggest that children exposed to mass trauma are at increased risk for the later development of panic, and those with a history of trauma are particularly vulnerable. Since there are effective and available treatments for panic, it may be clinically feasible to focus on panic among children in psychological evaluations and care in the aftermath of a massive traumatic event. Given panic has been associated with subsequent psychiatric problems, as well as academic and social functioning, successful intervention may have long term implications.

These results underscore the importance of unpacking traditional DSM classifications and consideration of ethnic background and nativity in children exposed to traumatic events. The findings also highlight the role of family among more acculturated Latino youth. Having a greater awareness of the cultural effects on the development or mitigation of mental disorders can not only lead to more robust culture-

specific intervention strategies, but it can also promote family involvement and de-stigmatizing the seeking of treatment.

NYC is a vast and complex urban landscape comprised of many culturally- and socioeconomically-clustered neighborhoods. The present assessment of neighborhood effects on PTSD sheds light on the many ways in which the urban landscape can impact a child's mental health, and, therefore, their long-term sequelae. This study provides a useful framework and set of methodologies for expanding our overall understanding of PTSD, the geographies of mental health, and the determinants of risk and resilience following large-scale events like 9/11, and provides evidence that geographic factors beyond mere proximity to a traumatic event are important determinants of PTSD risk. Our findings indicate that disadvantaged and low quality neighborhoods need to be a top priority for intervention efforts by local, state, and national government and health agencies, following any major disaster.

Context and Ethnic Diversity: Children's Responses to 9/11

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