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Cumulative exposure to work-related traumatic events and current post-traumatic stress disorder in New York City's first responders

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Abstract

Background and objectives: Cumulative exposure to work-related traumatic events (CE) is a foreseeable risk for psychiatric disorders in first responders (FRs). Our objective was to examine the impact of work-related CE that could serve as predictor of posttraumatic stress disorder (PTSD) and/or depression in FRs.
Design: Cross-sectional examination of previous CE and past-month PTSD outcomes and depression in 209 FRs.
Methods: Logistic (probable PTSD; probable depression) and Poisson regressions (PTSD score) of the outcomes on work-related CE indexes, adjusting for demographic variables. Differences across occupational groups were also examined. Receiver operating characteristic analysis determined the sensitivity and specificity of CE indexes.
Results: All indexes were significantly and differently associated with PTSD; associations with depression were non-significant. The index capturing the sheer number of different incidents experienced regardless of frequency ('Variety') showed conceptual, practical and statistical advantages compared to other indexes. In general, the indexes showed poor to fair discrimination accuracy.
Conclusions: Work-related CE is specifically associated with PTSD. Focusing on the variety of exposures may be a simple and effective strategy to predict PTSD in FRs. Further research on sensitivity and specificity of exposure indexes, preferably examined prospectively, is needed and could lead to early identification of individuals at risk.

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Over time, first responders (FRs) – police officers (POs), fire fighters (FFs), and emergency medical technicians (EMTs) – are confronted with multiple exposures to traumatic events. Cumulative exposure to traumatic events (CE) is significantly associated with post-traumatic stress disorder (PTSD) in the general population globally [1], in military personnel and veterans [2], and in refugees and other conflict-affected individuals [3]. Among FRs, professional training appears to mitigate risk of adverse response to major events and CE [4]; nevertheless, FRs present with considerable rates of PTSD. Following the September 11 terrorist attacks, the prevalence of PTSD ranged from 6.3% to 22.0% in FFs, from 6.5% to 14.1% in EMTs, and from 2.5% to 9.8% in POs (reviewed in [5]). Given the ongoing nature of their exposure, examining FRs affords an opportunity to elucidate the role of CE and accumulated risk [6]. Anticipating the *foreseeable* impact of the cumulative

burden and early identification of individuals at risk of PTSD could lead to timely interventions.

The measurement and scaling of CE pose significant challenges [6–8]. Weiss et al. [8] developed an instrument specifically designed to quantify the frequency and severity of work-related CE in POs, the Critical Incident History Questionnaire (CIHQ). The CIHQ differs from other measures of traumatic exposures in three main features. First, the CIHQ item content is tailored for FR occupational exposures. The questionnaire was conceived to cover a broad array of work-related critical incidents in FRs, based on trauma literature review, and consultations with police psychologists and police personnel. Second, the CIHQ offers better face validity for scaling the frequency of exposure. Respondents are asked to indicate the exact number of times relatively rare incidents were experienced (frequency 0 to 9), and to select from a range of frequencies for repetitively experienced incidents (10–20, 21–50, and >51). Developed in collaboration with police consultants, these response options address concerns about the accuracy of retrospective event counts, particularly among professionals with many years of service. Finally, the CIHQ estimates an event's severity based on appraisal independent of prior experience of the event; thus, a respondent's severity of exposure can be measured two ways: (1) by summing – for each incident experienced – the respondent's own severity rating; and (2) by summing the average severity rating in the sample. Weiss et al. [8] call these two approaches *idiographic* and *nomothetic*, respectively, and suggest that examining the correlation between the idiographic severity and nomothetic severity CE indexes would indicate whether incidents' severity ratings are consensually held judgments, not influenced by having personally experienced the incident/s (i.e., high correlation between idiographic and nomothetic severity indexes), or more idiosyncratic and potentially biased judgments, influenced by experience with the incident/s (i.e., low correlation between idiographic and nomothetic severity indexes).

Using the CIHQ, Weiss et al. [8] were the first to compare indexes that quantify CE using only frequency or severity (idiographic and nomothetic) of exposure, or incidents' frequency weighted by their severity. In their study on urban POs, all CE indexes showed satisfactory psychometric properties (coefficient alpha, and test–retest reliability). On average, the indexes were highly intercorrelated. The strong correlation between the nomothetic and idiographic scaling of severity showed that these two approaches were nearly interchangeable, and that assessment of severity is not biased by an officer's actual experience. The incidents' frequency was negatively correlated with their severity, suggesting that the perceived severity of a particular critical incident may be further understood relative to the likelihood that it will be encountered on the job. Finally, all CE indexes were only modestly related to PTSD symptoms. Thus, the authors concluded that there was no demonstrable advantage to indexing CE as a function of frequency and severity and that no index of CE demonstrated superior validity.

The CIHQ has also been applied to the measurement of work related CE in a recent study of POs (N = 193) from rural police departments [9]. CE indexes were found to have a high average correlation, very similar to the one reported by Weiss et al. [8]. A strong relationship between nomothetic and idiographic severity was also reported, even though not as high as the one found by Weiss and colleagues. Chopko et al. [9] concluded that this finding provides further evidence that personal experience with the event does not profoundly alter perception of incident severity. As in Weiss et al. [8], all CE indexes were only moderately related to PTSD symptoms.

In the current study we examined the relationship between work-related CE, measured with the CIHQ, and current PTSD in a sample of FRs who participated in a study on the impact of parental exposure to trauma on their children [10]. First, the association between CE indexes and PTSD was investigated with, in addition to correlation analysis as in previous studies [8,9], logistic and Poisson regressions of categorical and continuous outcomes, adjusting for several demographic and occupational variables (see Methods section). We then took this analysis further by determining the sensitivity and specificity of CE indexes, and providing cut-off scores of CE that would help identify individuals at higher risk of developing PTSD [6] in groups highly exposed to work-related critical incidents, such as FRs. This is an important novel aspect of the current study, since the lack of research on the sensitivity and specificity of exposure measures has hindered the capacity to promote occupational health [6]. Reliable cut-offs scores of CE indexes could significantly enhance early detection of at-risk FRs, improving secondary prevention and ultimately leading to timely intervention. Finally, given evidence in FRs linking chronic and cumulative occupational exposures to depression [11], our third aim was to assess the sensitivity and specificity of CIHQ indexes in detecting FRs with probable current depression; since the only study that examined the association between the CIHQ and depression in FRs did not find a significant relationship [12], we hypothesized that CE indexes would be useful to classify FRs with and without PTSD, but not FRs with and without depression.

1. Material and methods

1.1. Sample

Subjects were drawn from the Children of FRs and World Trade Center (WTC) Evacuees Study, described elsewhere [10]. Families of FRs were recruited from the WTC Health Registry (WTCHR), which was created in 2003 to monitor health outcomes following 9/11. A randomly selected sample of FRs and evacuee families (including a child age 9–16 living in the household) was identified in the WTCHR Registry, and invited to participate in the study. In person

interviews were conducted from March 2008 to November 2012 by trained New York State Psychiatric Institute research staff.

In an attempt to reduce the burden of a lengthy interview and target participants at higher PTSD risk, PTSD-related questions were limited to participants with lifetime exposure to at least one work-related incident rated as extremely severe on the CIHQ severity scale (see below), designed to measure severity as risk potential to cause symptoms [8]. The analytic sample includes 209 FRs (N = 32 EMTs, 99 FFs, and 78 POs) who were administered PTSD related questions. The mean age of the sample is 45.7 ± 5.2 years. Eighty-three percent are male, 21% are non-White, 12% are unmarried, and 11% had a yearly household income below $67,000. Finally, 12% had a high school diploma or less, 51% had some college, 27% were college graduates, and 9% had a graduate degree.

1.2. Measures

1.2.1. Work-related PTSD symptoms in the past month

Work-related PTSD symptoms were measured with the PTSD checklist, civilian version (PCL-C; [13]). Using a scale of 1 = *not at all* to 5 = *extremely*, respondents rate each DSM-IV PTSD symptom [14] to indicate the degree to which they have been bothered by that particular symptom over the past month. The PCL-C asks about symptoms in relation to generic "stressful experiences", rather than a specific event, simplifying assessment in the presence of multiple traumas [15]. The PCL-C yields a total symptom severity score (hereafter, PTSD score), obtained by summing the scores from each of the 17 items (range = 17–85), and a categorical presumptive diagnosis (hereafter, PTSD diagnosis), defined according to DSM-IV criteria (with the exclusion of criterion A, not part of the PCL-C); symptoms rated as "moderately" or above (responses 3 through 5) are counted as present [15].

1.2.2. Current symptoms of depression

Current ("*past 2 weeks including today*") depressive symptoms were measured with the Beck Depression Inventory for Primary Care (BDI-PC), a 7 item questionnaire (sadness, pessimism, past failure, loss of pleasure, self-dislike, self-criticalness, and suicidal thoughts/wishes), with each item rated on a 0–3 scale [16]. The BDI-PC is scored by summing ratings for each item (range 0–21), with a ≥ 4 cutoff score.

1.2.3. Frequency and severity of exposure to work-related critical incidents

An extended version of the CIHQ [8] was used to measure frequency and severity of work-related CE. Thirty-three of the 34 CIHQ incidents were included, except the item "*threatened with a gun*", since the item "*threatened with knife/other weapon*" was considered sufficient. Six items were added to assess exposure to terrorism (*nearby where terrorist activity occurred*") and war-related traumas (*fought in a war*; *being shot at in a battle*; *other life threatening experience while in a war*; *worked in a war-torn place*; *life threatening experience while in war-torn place*). Finally, respondents could indicate two events not previously listed, for a total of 41 incidents. Since, as mentioned in the Introduction, incidents' severity in the CIHQ was assessed independent of prior experience, in their study of POs Weiss et al. [8] asked participants to report how difficult it would be for POs in general to cope with each incident (from 0 = *not at all* to 4 = *extremely*), rather than how each participant might personally respond or imagine he/she might respond to an incident never directly experienced; we measured incidents' severity the same way, but we referred to "coworkers" instead of "police officers" as in previous studies [8,9] to reflect the heterogeneous sample of FRs.

1.2.4. CIHQ indexes

Six CIHQ indexes were constructed based on previous work [8].

1.2.4.1. Frequency approaches. Three indexes are based only on frequency of exposure. (1) *Actual Frequency* is expressed in values of 0–9, 15 (midpoint of 10–20), 35.5 (midpoint of 21–50), and 51. (2) *Recoded Frequency* uses an algorithm where 0 = 0, 1–9 = 1, 10–20 = 2, and ≥21 = 3. (3) *Variety* is the sum of the different types of incidents endorsed (range: 0–41).

1.2.4.2. Severity approaches. The assessment of each incident's severity independently of prior experience of the incident allows quantifying two indexes of severity of exposure. (1) *Idiographic Severity* is based on summing the participant's own severity rating for each incident experienced. (2) *Nomothetic Severity* is based on summing – for each incident experienced – the average severity rating in the sample.

1.2.4.3. Combined approach. This index weights the frequency value of an item (based on the actual frequency approach) by the nomothetic severity rating of that same item.

1.2.5. Event most related to PTSD symptoms

FRs reporting ≥1 PTSD symptom and exposed to ≥1 event were asked to indicate the event they were thinking about the most in relation to the reported PTSD symptoms; participants could only choose among events rated as extremely severe on the CIHQ severity scale.

1.3. Statistical analysis

As in Weiss et al. [8] and Chopko et al. [9], the association between exposure indexes, between the indexes and PTSD score, and between the mean frequency and mean severity rating of the events was examined with Spearman rank-order correlation. As in Weiss et al. [8], we examined the interrater reliability of severity ratings, calculating an intraclass correlation coefficient using a two-way mixed

effects model with nested random effects for the type of event and subject ID. The association of CE with both PTSD diagnosis and PTSD score [17], was examined with logistic and Poisson regressions, respectively, implemented in SAS [18], adjusting for the following demographic variables: gender, age, race (White vs. not White), marital status (married vs. not married: separated, divorced, widowed, or never married), income, education, and occupational group (POs, FFs, and EMTs). Exposure indexes and PTSD scores were standardized so that regression coefficients could be compared. The R-square (R^2) value [19] derived from logistic regressions in unadjusted models was used as an indicator of dispersion and variance in PTSD outcomes explained by CE indexes. In order to calculate sensitivity and specificity of CIHQ indexes in predicting current depression, we also examined the relationship between CIHQ indexes and depression, using logistic regression in SAS and adjusting for the same variables specified above. It should be noted that the CIHQ, as previously stated, was originally designed for POs; therefore, several items might have different frequencies and severity ratings in different occupational groups, and this could result in different associations with PTSD and depression across groups. To address this issue, the frequency and mean nomothetic severity rating of CIHQ items in Table 1 are shown for POs (N = 78) and FFs/EMTs (N = 131) separately. Furthermore, all regression analyses were run testing also the interaction between CIHQ indexes and occupation group (POs vs. FFs/EMTs). If the interaction term was significant, suggesting that the relationship between CIHQ indexes and the outcomes depends on the occupational group, regressions were run stratifying by occupational group. Receiver operating characteristic (ROC) analysis, implemented in SPSS version 19 [20], was used to determine the sensitivity and specificity of CE indexes in relation to the outcomes. The cut-point for each index was selected to maximize the sum of sensitivity and specificity.

2. Results

2.1. Incidents' frequency and severity

Frequency and mean nomothetic severity rating of each incident in POs and FFs/EMTs are shown in Table 1. The lowest mean severity rating was observed for making a mistake that injures/kills a bystander, in both POs (0.0) and FFs/EMTs (0.5); the highest mean severity rating (3.69) was reported by POs encountering a badly beaten child. Only 7 items had mean severity ratings that differed ($p < .05$) across occupational groups. However, only one of these events (*coworker killed accidentally*) had a difference greater than 0.5 (on a 0–4 scale). In the whole sample, the intraclass correlation coefficient, representing interrater reliability of severity ratings, was .63. More common events tended to be rated as less severe: the Spearman rank order correlation between the mean frequency and mean severity rating of the events was −.29 and marginally significant ($p = 0.0824$). In the whole sample, among FRs with one or more PTSD symptom, the events that were most frequently chosen as the ones most related to PTSD symptoms in the past month involved being present when a coworker was killed accidentally or intentionally (31% and 20% of symptomatic FRs who experienced the event, respectively), and exposure to a life threatening man-made disaster (27% of symptomatic FRs who experienced the event). Events involving children, although rated as very severe, were never chosen as the events most related to PTSD symptomatology.

2.2. CIHQ indexes descriptive statistics and intercorrelations

Correlations between CE indexes and descriptive statistics for the indexes in the whole sample are shown in Table 2. The 209 FRs, on average, reported exposure to more than 18 different types of critical incidents. Actual and Recoded Frequency indexes ($r = .998$, $p < .0001$), and Nomothetic and Idiographic Severity indexes ($r = .836$, $p < .0001$), were highly correlated. Variety, the third frequency-based index, was more strongly correlated to Nomothetic Severity ($r = .998$, $p < .0001$), and Idiographic Severity ($r = .836$, $p < .0001$) than to the other two frequency based indexes. The Combined Index was almost perfectly correlated with Actual Frequency ($r = .999$, $p < .0001$) and Recoded Frequency ($r = .921$, $p < .0001$) indexes.

2.3. Association between CIHQ indexes and PTSD outcomes

Descriptive statistics for PTSD symptoms and correlation between PTSD score and the six CE indexes are shown in Table 2. The mean PCL-C score was 27.5 (SD = 13.6). All indexes were significantly correlated with PTSD score. PTSD score showed the highest correlation with Idiographic Severity, and the lowest correlation with the Actual Frequency and Combined Approach indexes. The associations between CE indexes, PTSD diagnosis and PTSD score were examined using multiple logistic and Poisson regression analyses, adjusting for demographic variables; adjusted odds rations (AOR) and adjusted incidence rate ratio (AIRR) are shown in Table 3. Twenty four participants had a diagnosis of PTSD. Idiographic Severity showed the strongest relationship with PTSD outcomes, and accounted for the highest amount of dispersion in the outcome, followed by Nomothetic Severity and Variety. Actual Frequency and the Combined Approach were both weakly related to PTSD outcomes, and accounted for the least amount of variance in PTSD. The interaction between CIHQ indexes and occupational group was not statistically significant in logistic regressions. In Poisson regressions, the interaction with occupational group was significant ($p < .05$) for Actual Frequency, Recoded Frequency and the Combined Approach. In analyses stratified by occupation groups, AIRR (95% CI) in POs and FFs/EMTs were, respectively, 1.04 (1.00, 1.08) and 1.09 (1.05, 1.13) for Actual Frequency, 1.06 (1.02, 1.11) and 1.14 (1.10, 1.19) for

Table 1
Actual frequency (0, 1–9, 10–20, 21–50, >50) and mean nomothetic severity rating (SD) of CIHQ items in police officers (N = 78) and fire fighters/EMTs (N = 131).

	Police officers						Fire fighters/EMTs					
	Actual frequency (%)					Mean Sev.	Actual frequency (%)					Mean Sev.
	0	1–9	10–20	21–50	>50		0	1–9	10–20	21–50	>50	
Seriously injured intentionally	74.1	21.4	3.8	0.8	0.0	2.38 (1.09)	52.6	32.1	11.5	3.9	0.0	2.21 (1.23)
Seriously injured accidentally	15.3	57.3	19.1	8.4	0.0	1.92 (1.03)	33.3	57.7	6.4	2.6	0.0	2 (1.25)
Coworker killed intentionally	75.6	24.4	0.0	0.0	0.0	3.51 (0.8)	60.3	37.2	1.3	1.3	0.0	3.51 (0.8)
Coworker injured intentionally	57.3	33.6	6.1	1.5	1.5	2.98 (1.03)	33.3	43.6	15.4	7.7	0.0	2.69 (1.1)
Coworker injured accidentally[a,*]	13.0	34.4	28.2	13.7	7.6	2.47 (1.03)	25.6	55.1	12.8	6.4	0.0	2.37 (1.14)
Coworker killed accidentally	48.9	50.4	0.8	0.0	0.0	3.61 (0.7)	76.9	23.1	0.0	0.0	0.0	3.1 (1.2)
Being seriously beaten	88.6	10.7	0.8	0.0	0.0	2.89 (1.11)	73.1	26.9	0.0	0.0	0.0	2.62 (1.2)
Being taken hostage	95.4	4.6	0.0	0.0	0.0	3.34 (1.03)	100.0	0.0	0.0	0.0	0.0	3.14 (1.17)
Your loved ones threatened*	89.3	8.4	2.3	0.0	0.0	0.13 (0.4)	70.5	21.8	6.4	1.3	0.0	0.38 (0.67)
Being shot at	64.9	30.5	4.6	0.0	0.0	3.07 (1.07)	44.9	52.6	2.6	0.0	0.0	3.14 (1.02)
Threatened with knife/other weapon[a]	40.5	51.2	6.9	0.8	0.0	2.84 (0.96)	20.5	48.7	23.1	5.1	2.6	2.74 (1.05)
Trapped in life threatening situation	21.4	65.7	8.4	3.8	0.8	3.19 (0.9)	29.5	56.4	5.1	3.9	5.1	3 (0.99)
Exposed to risk of AIDS/diseases[a,b,*]	11.5	32.8	19.9	11.5	17.6	2.69 (1.12)	12.8	41.0	21.8	11.5	11.5	3.01 (0.89)
Life threatened by dangerous animal	59.5	36.6	3.1	0.8	0.0	2.27 (1.09)	41.0	52.6	5.1	1.3	0.0	2.41 (1.07)
Life threatened by toxic substance[a,b]	29.0	34.4	12.2	1.5	17.6	2.64 (1.08)	44.9	41.0	3.9	1.3	7.7	2.87 (1.02)
Kill/injure in line of duty	87.8	11.5	0.8	0.0	0.0	3.23 (1.1)	68.0	30.8	1.3	0.0	0.0	3.05 (1.06)
Shoot but not injure in line of duty[a]	96.2	3.1	0.0	0.0	0.0	3.05 (1.18)	79.5	20.5	0.0	0.0	0.0	2.76 (1.28)
Mistake that injures/kill coworker	96.2	3.8	0.0	0.0	0.0	3.59 (0.91)	94.9	5.1	0.0	0.0	0.0	3.49 (1.02)
Mistake that injures/kill bystander[a,*]	93.9	5.3	0.0	0.0	0.0	0.05 (0.23)	100.0	0.0	0.0	0.0	0.0	0 (0)
Life threatening high speed chase	80.9	10.7	4.6	0.8	3.1	2.38 (1.18)	15.4	44.9	18.0	12.8	9.0	2.4 (1.19)
Seeing someone dying[a,b]	3.8	32.8	26.7	13.7	17.6	2.66 (1.11)	10.3	38.5	26.9	14.1	7.7	2.68 (1.08)
Body of someone recently dead[a,b]	3.8	19.9	26.0	22.9	19.9	2.37 (1.22)	9.0	25.6	21.8	14.1	26.9	2.22 (1.21)
Decaying corpse[a,b]	17.6	45.0	16.0	7.6	9.9	2.56 (1.21)	16.7	39.7	23.1	9.0	9.0	2.43 (1.2)
Mutilated body/human remains[a,b]	16.0	38.2	16.0	12.2	12.2	2.84 (1.17)	20.5	44.9	20.5	6.4	5.1	2.66 (1.12)
Making a death notification[a,b]	35.9	38.9	10.7	6.1	5.3	3.02 (1.12)	25.6	48.7	10.3	6.4	7.7	2.88 (1.08)
Sexually assaulted child[a,b]	64.1	26.7	3.8	3.1	1.5	3.59 (0.69)	32.1	44.9	15.4	3.9	1.3	3.4 (0.74)
Sexually assaulted adult[a,b,*]	44.3	39.7	5.3	5.3	3.8	2.89 (0.98)	19.2	41.0	19.2	9.0	10.3	2.54 (1)
Badly beaten child[a,b,*]	50.4	42.0	2.3	2.3	0.8	3.69 (0.54)	37.2	41.0	12.8	6.4	1.3	3.42 (0.73)
Badly beaten adult[a,b,*]	10.7	42.8	23.7	12.2	6.9	1.53 (0.94)	7.7	32.1	20.5	12.8	24.4	1.89 (1.01)
Severely neglected child[b]	37.4	44.3	14.5	2.3	1.5	3.4 (0.72)	26.9	43.6	18.0	9.0	1.3	3.24 (0.84)
Animal neglected/injured/killed[b]	30.5	48.9	13.0	6.1	1.5	2.35 (0.91)	23.1	51.3	12.8	7.7	3.9	2.15 (1.05)
Life threatening man-made disaster[a]	19.9	61.8	6.9	4.6	4.6	3.15 (0.96)	25.6	69.2	3.9	1.3	0.0	3.19 (0.9)
Life threatening natural disaster	67.2	29.0	3.1	0.0	0.8	2.76 (0.97)	78.2	20.5	1.3	0.0	0.0	2.72 (1.17)
Fought in war/other hostilities	93.9	6.1	0.0	0.0	0.0	3.38 (1.19)	89.7	10.3	0.0	0.0	0.0	3 (1.2)
Shot/received fire in a battle	96.2	3.1	0.8	0.0	0.0	3.13 (1.25)	93.6	6.4	0.0	0.0	0.0	2.5 (1.69)
Life threatened in war/ other hostilities	97.0	3.1	0.0	0.0	0.0	2.88 (1.36)	94.9	5.1	0.0	0.0	0.0	2.5 (1.41)
Civilian in a place during war	85.5	14.5	0.0	0.0	0.0	2.87 (1.1)	92.3	6.4	1.3	0.0	0.0	2.93 (1.24)
Life threatened in war zone as civilian	97.7	2.3	0.0	0.0	0.0	3.26 (0.93)	96.2	2.6	1.3	0.0	0.0	3.33 (1.21)
Nearby terrorist activity	48.9	48.9	2.3	0.0	0.0	0.53 (0.54)	53.9	42.3	3.9	0.0	0.0	0.5 (0.58)

[a,b] The percentages do not add to 100% because of missing data in POs ([a]) and/or FFs/EMTs ([b]). The items in italics were added to the original Critical Incident History Questionnaire.

* Differences in mean nomothetic severity ratings across occupational groups are significant at $p < .05$.

Recoded Frequency, and 1.04 (1.00, 1.08) and 1.09 (1.05, 1.13) for the Combined Approach. These differences in AIRR values were not considered clinically meaningful; the largest difference, observed for Recoded Frequency, indicates that for a one-unit increase in the Recoded Frequency index, FFs/EMTs have an additional 0.08 times greater PCL score compared to POs.

2.4. Sensitivity and specificity of CIHQ indexes

Results from the ROC analysis for the six CE indexes and PTSD diagnosis as the outcome are shown in Table 4. The area under the curve (AUC) of Idiographic Severity showed that this index had the highest discrimination accuracy (AUC = .794, 95% CI = .713–.874; sensitivity = .833, specificity = .659); AUC values for other indexes indicated poor discriminant accuracy (AUC's < .70). Using the index specific cut-off scores selected to maximize sensitivity and specificity, the highest sensitivity values were observed for Variety and Nomothetic Severity; the highest specificity values were observed for Idiographic Severity, Actual Frequency, and the Combined Approach. Actual Frequency and the Combined Approach were virtually identical on all dimensions. None of the CIHQ indexes was associated with

Table 2
Spearman correlations and descriptive statistics for the six cumulative exposure indexes and PCL-C PTSD score in the whole sample (N = 209).

Variables	1	2	3	4	5	6	Mean (*SD*)	Range
1. Actual Frequency							205.0 (159.2)	3–820
2. Recoded Frequency	.92						27.5 (12.6)	2–67
3. Variety	.64	.87					18.5 (6.3)	2–32
4. Nomothetic Severity	.64	.87	.99				54.4 (19.1)	6–95
5. Idiographic Severity	.46	.68	.84	.84			49.4 (20.5)	4–121
6. Combined Approach	.99	.92	.65	.64	.46		583.3 (460.2)	9–2375
Current PTSD Score	.14*	.19**	.22**	.22**	.32***	.14*	27.5 (13.6)	13–82

All correlations between cumulative exposure indexes were significant at $p < .001$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

current depression, and no logistic regression models showed a significant interaction between CIHQ indexes and occupational groups. Since there was no significant relationship between CE and depression, ROC analysis was not performed.

3. Discussion

This study examined the relationship between indexes of CE to work-related incidents and PTSD outcomes (score and diagnosis) in a sample of over 200 FRs. There were four main findings. 1) All six indexes examined were significantly associated only with current PTSD diagnosis and score, and not with depression; idiographic severity demonstrated the strongest association with PTSD outcomes. 2) Weighting frequency counts by event severity (Combined Approach) had no impact on the association between CE and PTSD outcomes beyond frequency alone. 3) The index based on the variety of occupational exposures was equivalent to the average (nomothetic) severity index in its association with PTSD outcomes. 4) Only Idiographic Severity demonstrated adequate discrimination for identifying PTSD diagnosis.

Mean severity ratings were in general similar across POs and FFs/EMTs; differences across groups in events' frequencies did not produce differences in the association of CIHQ indexes with PTSD diagnosis, and were associated with marginal differences in the association of three CIHQ indexes with PTSD score. This result is important, also given the similarities (discussed below) between our study in POs and FFs/EMT and previous studies of POs from urban [8] and rural [9] areas, because it suggests that findings identified in POs in our study and previous studies might likely be generalizable also to FFs and EMTs. Furthermore, these results indicate that the CIHQ – initially developed for POs – might be appropriate to measure work-related CE also in other groups of FRs, such as FFs and EMTs.

Mean levels of exposure were similar to the ones reported by these previous studies; for example, the mean scores for Variety across the three studies were in the range 15.60–18.50. Four of the six critical events with the highest nomothetic severity ratings in both POs and FFs/EMTs were common across studies (making a mistake that injures/kills a coworker, being present when a coworker was killed intentionally or accidentally, and being taken hostage). The mean nomothetic severity ratings for these four events were also comparable (ranges 3.10–3.61, 3.49–3.81, and

Table 3
R^2, adjusted odds ratios (AOR), and adjusted incidence rate ratios (AIRR) for the six cumulative exposure indexes in the whole sample, with PTSD diagnosis (logistic regressions) and symptom score (Poisson regressions) as the dependent variables.*

	Logistic regressions		Poisson regressions
Cumulative Exposure Indexes	R^2	AOR (95% CI)	AIRR (95% CI)
Actual Frequency	0.08	1.57 (1.00–2.49)	1.07 (1.04, 1.10)****
Recoded Frequency	0.10	2.01 (1.20–3.34)**	1.12 (1.09, 1.15)****
Variety	0.11	2.83 (1.45–5.52)**	1.17 (1.14, 1.20)****
Nomothetic Severity	0.12	2.90 1.48–5.68)**	1.17 (1.14, 1.20)****
Idiographic Severity	0.18	5.18 (2.36–11.33)***	1.23 (1.20, 1.27)****
Combined Approach	0.08	1.57 (1.00–2.48)	1.07 (1.05, 1.10)****

AOR and AIRR values are adjusted for gender, age, race, marital status, income, education, and occupational group.
* $p < .05$.
** $p < .01$.
*** $p < .001$.
**** $p < .0001$.

Table 4
Results from ROC analysis in the whole sample: cut-off scores, sensitivity, specificity, and area under the curve (AUC) of the six cumulative exposure indexes.

Cumulative Exposure Indexes	Cut-off	% Sensitivity	% Specificity	AUC (95% CI)
Actual Frequency	210.25	.625	.638	.620 (.500–.741)
Recoded Frequency	23.50	.833	.449	.663 (.562–.764)
Variety	15.50	.958	.324	.662 (.565–.759)
Nomothetic Severity	46.28	.958	.357	.666 (.569–.762)
Idiographic Severity	53.50	.833	.659	.794 (.713–.874)
Combined Approach	591.73	.625	.638	.622 (.503–.741)

3.46–3.86, respectively, in the present study, and in the studies by Weiss et al. [8] and Chopko et al. [9]). Unlike the latter two studies, in this sample incidents involving children (encountering a child who has been badly beaten, sexually assaulted, or severely neglected) were among the events rated as most severe, although they were never chosen as those most related to current PTSD symptomatology. Those that were so identified included two of the incidents mentioned above (being present when a coworker was killed intentionally or accidentally), and being in a life threatening large-scale man-made disaster. Making a mistake that injures/kill a coworker and being taken hostage – although rated as very severe – were never chosen as events most related to current PTSD symptomatology, possibly due to a very low frequency of occurrence. Neither Weiss et al. nor Chopko et al. asked participants to identify the event which was most related to current PTSD symptoms, so comparisons cannot be made. As in the previous two studies on POs, we found a negative association between frequency of exposure and the incident's severity rating. However, the negative correlation here (−.29) was not as strong as in the studies by Weiss et al. and Chopko et al. (−.61, and −.67, respectively; $p < .001$), and was only marginally significant ($p < .1$).

The correlations between the indexes also replicated across studies: the average correlation coefficient was .76, compared to .83 and .80 from Weiss et al. and Chopko et al., respectively. The correlation between Nomothetic Severity and Idiographic Severity in this study (.84) was very similar to the one reported by Weiss et al. (.85), and slightly higher than that reported by Chopko et al. (.68). As in the other two studies, Idiographic Severity showed the lowest average correlation with the other indexes. The almost perfect correlation between Variety and Nomothetic Severity (.99) replicates the report of Weiss et al. (.99). The intraclass correlation coefficient representing interrater reliability of severity ratings was lower than the one reported by Weiss et al. (.63 compared to .94, respectively).

The correlations between CE indexes and PTSD score, and the differences between indexes in their association with PTSD score, were also comparable across the three studies. Correlation coefficients in this study were almost identical to the ones reported by Weiss et al. in urban POs; for example, PTSD score showed almost the same correlation with Variety in this study (.22) and in the one by Weiss et al. (.21). Correlations between CE indexes and PTSD score in our study and in the Weiss et al. study of urban FRs were lower than the ones reported by Chopko et al. in POs coming from rural areas. All studies concurred in finding Idiographic Severity more strongly related to PTSD score, and Actual Frequency less correlated to PTSD score. Our work extends these findings to PTSD score, and PTSD diagnosis, controlling for demographic characteristics. Consistent with findings from correlation analysis, in regression analysis Actual Frequency and the Combined Approach showed the weakest relationship with PTSD outcomes, followed by Recoded Frequency, and explained the least amount of variance in PTSD outcomes. The strongest relationship was again found for Idiographic Severity; this index also explained the largest amount of variation in the outcome.

In reviewing these findings, several questions arise in scaling cumulative occupational exposure. First, does past experience with an event alter one's judgment of its severity? Weiss et al. and Chopko et al. suggest that the high correlation between idiographic and nomothetic ratings indicate that severity appraisal is independent of experience. Nevertheless, even though the two indexes were strongly correlated in Weiss et al. study, the correlation observed by Chopko et al. was considerably lower (.85 compared to .68, respectively). Furthermore, evidence that the association of PTSD outcomes with Idiographic Severity is stronger than with Nomothetic Severity implies that there is a difference to be explained. In our sample, among subjects with PTSD diagnosis, the mean Idiographic Severity score was higher (69.4 ± 20.4) than the mean Nomothetic Severity score (64.8 ± 15.0), and among subjects without PTSD diagnosis the mean Idiographic Severity score was lower (46.8 ± 19.1) than the mean Nomothetic Severity score (53.0 ± 19.2). Thus, it seems that people without PTSD diagnosis tend to consider the incidents that they experienced as less severe, compared to the average severity rating of the same incidents in the whole sample. Also, even though in the whole sample Idiographic Severity was strongly correlated with Nomothetic Severity, the correlation – although still large and significant – was lower in people with PTSD diagnosis (.764, $p < .0001$), while in people without PTSD it was very similar to the one observed in the whole sample (.850, and .837, respectively; $p < .0001$). Thus, idiographic severity ratings may be reflecting current symptoms, explaining in part the strong association with PTSD outcomes across every analysis. Individuals with more

severe PTSD symptomatology or a full-blown syndrome might involuntarily or intentionally overestimate the severity of experienced events, by reporting the highest level of difficulty for coworkers to normalize their own experience. A longitudinal study of the relationship between CE and PTSD in FRs could examine whether idiographic severity ratings partially depend on PTSD severity; it could be expected that Idiographic Severity, compared to other indexes, would show a lower test–retest reliability, and would be more strongly correlated with fluctuations in PTSD severity over time. Nomothetic Severity might be less biased, since the severity of events is measured based on average rated severity in the whole sample. Finally, based on reports from the study's interviewers, we noted that incidents' severity was in general easier to rate for more common incidents, and more difficult for rare events; also, some respondents had difficulties rating incidents' severity, regardless of frequency of occurrence, since they would argue that people react differently to the same event.

Second, does the almost perfect correlation between Nomothetic Severity and Variety, reinforced by the findings from correlations and regression analyses examining PTSD outcomes, imply that there is no conceptual or statistical advantage in measuring work-related CE as a function of severity, as suggested by Weiss et al. [8] and Chopko et al. [9]? The almost perfect correlation between these two indexes is likely due to the fact that nomothetic severity ratings in this study, and in the studies by Weiss et al. and Chopko et al., are within a narrow range. Thus, the two indexes represent the same level of CE, just on two different scales, and are practically interchangeable. Considering that Idiographic Severity might already be reflecting current PTSD symptoms, the general issues related to the assessment of severity in the CIHQ, and the very similar association that Variety and Nomothetic Severity showed with PTSD outcomes, there seems to be no conceptual, statistical or practical advantage in measuring CE as a function of severity, as suggested also by Weiss et al. [8] and Chopko et al. [9]. Thus, especially in individuals routinely exposed to multiple work-related events, a briefer, efficient and clinically useful strategy to monitor CE might be to simply count the variety of exposure (i.e., the number of different events experienced), the simplest approach to the measurement of exposure among the ones described by the authors of the CIHQ. This may be especially useful in settings where simple tools to monitor exposure may have important applications [21]. Interestingly, a similar result was recently obtained in a different sample of Ugandan war survivors, in which lifetime PTSD was most accurately predicted by the number of different traumatic event types experienced, while inclusion of event frequencies only marginally improved current PTSD prediction [22]. In agreement with our conclusion, those authors recommended using the number of traumatic events experienced as an indicator of PTSD risk, because it is the briefest and least stressful assessment, and leads to the best prediction of PTSD.

Third, can cumulative occupational exposure predict PTSD score and diagnosis in a meaningful way? Without "getting personal" – tapping into traumatic exposures experienced off the job and personal vulnerabilities – does cumulative occupational exposure by any method capture posttraumatic stress symptomatology? ROC analysis provided a quantitative measure of the discrimination ability of CE indexes to correctly classify FRs with and without PTSD. The AUC values, with the exception of Idiographic Severity, were all smaller than .70, indicating a poor accuracy in discriminating PTSD cases. In general, the identified cut-off scores, which maximized the AUC, showed higher sensitivity (fewer missed PTSD cases) and lower specificity (more false positives). On the assumption that it is worse to miss a PTSD case than to endure additional screening and a clinical interview for a false positive, choosing a higher sensitivity cut-off might provide some advantages. Compared to Idiographic Severity, Variety had higher sensitivity and lower specificity. However, Actual Frequency had a specificity value similar to Idiographic severity. Thus, following the previous conclusion that there might be no advantage in measuring CE as a function of severity, Variety could be initially used to identify a "true" PTSD case, and Actual Frequency could then help identifying false positives that might be misclassified as PTSD cases using the Variety approach, due to its low specificity. Research on sensitivity and specificity of exposure indexes could be informative for risk management and clinical decisions. The identification of cut-off scores of CE with satisfactory sensitivity and specificity values could help monitor the progressive burden of exposure in FRs and anticipate adverse outcomes [6]. Occupational groups with a high risk of trauma exposure are in need of screening tools that address under-reporting of PTSD symptoms by symptomatic individuals, due to fear of potential disadvantage and discrimination [6]. Screening for exposure might be less vulnerable to discrimination and under-reporting, and could provide useful additional information to identify individuals at risk, thus allowing for the allocation of resources on FRs in need. The most appropriate action to take with FRs identified as potentially at-risk, based on their level of exposure, would be to assess them for other risk indicators, such as poor performance at work or severe interpersonal difficulties [6], and ensure that these individuals are monitored for PTSD and other outcomes associated with PTSD and CE, such as functional impairment, an comorbidity with mood and anxiety disorders [1]. Also, exposure scores could be used to inform a strategy suggested by McFarlane & Bryant [6], initially developed according to risks known to be associated with prolonged military combat exposure, that is to have a rotation of duties; in this case, when a FR is close to or reaches an exposure threshold (like the ones shown in this paper), she/he could be monitored more closely and given an opportunity to receive counseling or mental health assistance, and eventually be taken off active duty until the risk of adverse consequences decreases. However, it is important to consider that this approach does

not imply that screening positive for exposure (i.e., being above a specified threshold) necessarily points to PTSD, nor that PTSD can be predicted only by exposure screening. Second, other adverse consequences are often associated with PTSD and CE, such as mood and anxiety disorders [1]. However, as shown for the first time in this paper, work-related CE, measured with the CIHQ, is specifically associated with PTSD; screening for CE does not work well to predict current depression, and might not work well to predict other disorders. Third, exposure-related adverse consequences can manifest in different ways, such as PTSD with delayed expression [6], and more research is needed to understand how indexes of CE are associated with delayed traumatic reactions. Fourth, exposure to a major single traumatic event is sufficient to trigger PTSD; additional research is needed to understand how such an event might interact with pre-existing CE levels to predict PTSD and other outcomes. Finally, more research is also needed on how sensitivity and specificity of exposure indexes may vary based on gender, age, years of service, and other individual differences. Thus, at present, screening for exposure should only be considered as complementary to screening for PTSD and other negative outcomes of exposure.

The current study has several limitations. First, PTSD-related questions were limited to participants exposed to at least one work-related incident rated as extremely severe on the CIHQ severity scale. This may have inflated even more the relationship between PTSD and Idiographic Severity, and, to a lesser extent, Nomothetic Severity although the similarity of correlations across studies suggests this is not the case. Second, PTSD and depression were assessed with screening tools, and diagnosis should therefore be considered as probable. Third, the time and duration of exposure to specific events, and the time gap between exposures and current PTSD/depression were not taken into account; however, post hoc analyses adjusted for the length of time of exposure (years on the job), in a subsample for which this information was available, showed that results were substantially the same.

In this study, like in previous studies by Weiss et al. and Chopko et al. – the association between PTSD and CE indexes was only moderate. Clearly, there are many other exposure-related variables that contribute to PTSD symptomatology and are not captured by the measurement of CE through the CIHQ. The CIHQ focuses only on frequency of exposure, and on one specific way of assessing severity. However, the conceptualization and measurement of exposure to negative events is more complex, and this complexity has made the associations with psychopathology difficult to interpret [7]. For example, according to Dohrenwend [7], source, valence, unpredictability, magnitude, centrality, and tendency to exhaust the individual physically are important general characteristics of negative events that constitute major determinants of the onset and persistence of a wide range of psychopathology, including PTSD. Conducting such a systematic assessment of exposure might be unrealistic in the context of an epidemiological study. However, work places with a high risk of exposure to negative events should consider such an extensive assessment, which might contribute not only relevant information to prevent more costly adverse consequences but also valuable data that would move this field of research forward. Furthermore, an adequate assessment of lifetime CE is – especially in the case of PTSD research and in populations highly exposed to traumatic events – a necessary step to understand how other environmental risk factors, as well as physiological, neurocognitive, endocrinological, genetic and molecular factors (for a review see [23]), influence the etiology and course of PTSD.

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References

[1] Karam EG, Friedman MJ, Hill ED, Kessler RC, McLaughlin KA, Petukhova M, et al. Cumulative traumas and risk thresholds: 12-month Ptsd in the world mental health (Wmh) surveys. Depress Anxiety 2014; 31(2):130-42, http://dx.doi.org/10.1002/da.22169.

[2] Xue C, Ge Y, Tang BH, Liu Y, Kang P, Wang M, et al. A meta-analysis of risk factors for combat-related PTSD among military personnel and veterans. PLos One 2015;10(3)e0120270, http://dx.doi.org/10.1371/journal.pone.0120270.

[3] Steel Z, Chey T, Silove D, Marnane C, Bryant RA, van Ommeren M. Association of torture and other potentially traumatic events with mental health outcomes among populations exposed to mass conflict and displacement: a systematic review and meta-analysis. JAMA 2009; 302(5):537-49, http://dx.doi.org/10.1001/jama.2009.1132.

[4] Perrin MA, DiGrande L, Wheeler K, Thorpe L, Farfel M, Brackbill R. Differences in PTSD prevalence and associated risk factors among world trade center disaster rescue and recovery workers. Psychiatry 2007;164(9):1385-94, http://dx.doi.org/10.1176/appi.apj.2007.06101645.

[5] Wilson LC. A systematic review of probable posttraumatic stress disorder in first responders following man-made mass violence. Psychiatry Res 2015, http://dx.doi.org/10.1016/j.psychres.2015.06.015.

[6] McFarlane AC, Bryant RA. Post-traumatic stress disorder in occupational settings: anticipating and managing the risk. Occup Med (Lond) 2007;57(6):404-10, http://dx.doi.org/10.1093/occmed/kqm070.

[7] Dohrenwend BP. Toward a typology of high-risk major stressful events and situations in posttraumatic stress disorder and related psychopathology. Psychol Inj Law 2010;3(2):89-99, http://dx.doi.org/10.1007/s12207-010-9072-1.
[8] Weiss DS, Brunet A, Best SR, Metzler TJ, Liberman A, Pole N, et al. Frequency and severity approaches to indexing exposure to trauma: the critical incident history questionnaire for police officers. J Trauma Stress 2010;23(6):734-43, http://dx.doi.org/10.1002/Jts.20576.
[9] Chopko BA, Palmieri PA, Adams RE. Critical incident history questionnaire replication: frequency and severity of trauma exposure among officers from small and midsize police agencies. J Trauma Stress 2015;28(2):157-61, http://dx.doi.org/10.1002/jts.21996.
[10] Hoven CW, Duarte CS, Wu P, Doan T, Singh N, Mandell DJ, et al. Parental exposure to mass violence and child mental health: the first responder and WTC evacuee study. Clin Child Fam Psychol Rev 2009;12(2):95-112, http://dx.doi.org/10.1007/s10567-009-0047-2.
[11] Walker A, McKune A, Ferguson S, Pyne DB, Rattray B. Chronic occupational exposures can influence the rate of PTSD and depressive disorders in first responders and military personnel. Extrem Physiol Med 2016;5:8, http://dx.doi.org/10.1186/s13728-016-0049-x.
[12] Wang Z, Inslicht SS, Metzler TJ, Henn-Haase C, McCaslin SE, Tong H, et al. A prospective study of predictors of depression symptoms in police. Psychiatry Res 2010;175(3):211-6, http://dx.doi.org/10.1016/j.psychres.2008.11.010.
[13] Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD checklist (PCL). Behav Res Ther 1996;34(8):669-73.
[14] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, D.C.: American Psychiatric Association; 1994
[15] U.S. Department of Veterans Affairs-National Center for PTSD. Using the PTSD checklist for DSM-IV (PCL); 2012.
[16] Beck AT, Guth D, Steer RA, Ball R. Screening for major depression disorders in medical inpatients with the Beck depression inventory for primary care. Behav Res Ther 1997;35(8):785-91.
[17] Haslam N, Holland E, Kuppens P. Categories versus dimensions in personality and psychopathology: a quantitative review of taxometric research. Psychol Med 2012;42(5):903-20, http://dx.doi.org/10.1017/S0033291711001966.
[18] S.A.S. Institute Inc. Statistical analysis system. 91 ed. Cary, NC: SAS Institute; 2007.
[19] S.A.S. Institute Inc. Generalized coefficient of determination. SAS/STAT(R) 9.2 User's guide, second edition. Retrieved from https://support.sas.com/documentation/cdl/en/statug/63033/HTML/default/viewer.htm#statug_logistic_sect031.htm2016.
[20] SPSS Inc. SPSS Base 19.0 for windows User's guide. Chicago, IL: Author; 2010.
[21] Boscarino JA, Kirchner HL, Hoffman SN, Sartorius J, Adams RE, Figleg CR. A brief screening tool for assessing psychological trauma in clinical practice: development and validation of the New York PTSD risk score. Gen Hosp Psychiatry 2011;33(5):489-500, http://dx.doi.org/10.1016/j.genhosppsych.2011.06.001.
[22] Wilker S, Pfeiffer A, Kolassa S, Koslowski D, Elbert T, Kolassa IT. How to quantify exposure to traumatic stress? Reliability and predictive validity of measures for cumulative trauma exposure in a post-conflict population. Psychotraumatol 2015;6:28306, http://dx.doi.org/10.3402/ejpt.v6.28306.
[23] Pitman RK, Rasmusson AM, Koenen KC, Shin LM, Orr SP, Gilbertson MW, et al. Biological studies of post-traumatic stress disorder. Nat Rev Neurosci 2012;13(11):769-87, http://dx.doi.org/10.1038/nm3339.