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REGULAR ARTICLE

Maladaptive Personality Traits and 10-Year Course of Psychiatric and Medical Symptoms and Functional Impairment Following Trauma

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Abstract

Background Personality is a major predictor of many mental and physical disorders, but its contributions to illness course are understudied.

Purpose The current study aimed to explore whether personality is associated with a course of psychiatric and medical illness over 10 years following trauma.

Methods World Trade Center (WTC) responders (N = 532) completed the personality inventory for DSM-5, which measures both broad domains and narrow facets. Responders' mental and physical health was assessed in the decade following the WTC disaster during annual monitoring visits at a WTC Health Program clinic. Multilevel modeling was used in an exploratory manner to chart the course of health and functioning, and examine associations of maladaptive personality domains and facets with intercepts (initial illness) and slopes (course) of illness trajectories.

Results Three maladaptive personality domains—negative affectivity, detachment and psychoticism—were uniquely associated with initial posttraumatic stress disorder (PTSD); detachment and psychoticism were also associated with initial functional impairment. Five facets—emotional lability, anhedonia, callousness, distractibility and perceptual dysregulation—were uniquely associated with initial mental and physical health and functional impairment. Anxiousness and depressivity facets were associated with worse initial levels of psychiatric outcomes only. With regard to illness trajectory, callousness and perceptual dysregulation were associated with the increase in PTSD symptoms. Anxiousness was associated with greater persistence of respiratory symptoms.

Conclusions Several personality domains and facets were associated with initial levels and long-term course of illness and functional impairment in a traumatized population. Results inform the role of maladaptive personality in the development and maintenance of chronic mental-physical comorbidity. Personality might constitute a transdiagnostic prognostic and treatment target.

Keywords Gastroesophageal reflux disease • Mental-physical comorbidity • Personality facets • Posttraumatic stress disorder • Respiratory conditions • World Trade Center

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Introduction

Trauma often leads to a range of long-term negative health outcomes, including an increased risk of mental

and physical illness and functional impairment [1–4]. Given a high disease burden resulting from traumatic experiences, it is crucial to understand maintenance factors of chronic symptoms and functional impairment post-trauma. Personality traits have emerged as prospective predictors of health outcomes in the general population [5–13], over and above traditional predictors such as socio-economic status and IQ levels. Personality is also among top vulnerability and resilience factors in response to trauma and disasters [14–17]. Prospective studies revealed that vulnerable personality traits, such as neuroticism, may impede recovery from the health sequelae of traumas [18–21], while protective traits such as extraversion and conscientiousness can facilitate resilience to stress [22–24] and recovery if disorders occur [25–27]. Again, these effects are observed beyond the effects of traditional vulnerability and residence factors.

Outstanding Questions in Personality-Health Link

There are important limitations to the current understanding of long-term associations between personality and post-trauma health. First, the link between personality and the *course* of illness and functional impairment is largely unexplored. Personality can be associated with initial individual differences in vulnerability to health and functional impairments, but it is equally important to investigate whether it is further linked with the course and maintenance of these problems over and above these baseline differences [28, 29].

Second, to date research has almost exclusively focused on broad personality domains. However, in leading theoretical conceptualizations, personality is organized hierarchically, with specific *facets* within general trait domains (e.g. extraversion is thought to contain facets such as positive emotionality, sociability, and ascendance). These narrow facets tend to demonstrate greater predictive power than the broad domains, and facets within a given domain may be differently associated with health outcomes [30–37]. Thus, to fully understand the association between personality traits and illness, specific facets should be explored alongside the broad domains.

Third, a vast majority of research has focused on dimensions of normal personality. The Diagnostic and Statistical Manual of Mental Disorders (5th ed., DSM-5) [38] introduced a comprehensive dimensional model of personality pathology operationalized by the Personality Inventory for DSM-5 (PID-5) [39]. Maladaptive traits are particularly relevant for the study of health problems, as they capture clinically significant personality characteristics. The PID-5 domains broadly map on domains of normal personality: negative affectivity corresponds to neuroticism, detachment to low extraversion, disinhibition to low conscientiousness and antagonism to low agreeableness, with the PID-5 including additional psychoticism domain [40, 41]. Although at the lower level of the hierarchy the number and the nature of narrow personality facets differs across conceptualizations, the PID-5 consists of 25 facets, providing a consensus system of specific elements of the personality hierarchy developed by the DSM-5 Personality and Personality Disorders Workgroup. However, little is known about the relations between the PID-5 and health, especially longitudinally.

Personality and World Trade Center-Related Illness

Given the importance of personality for health outcomes in traumatized populations, we aimed to investigate for the first time whether personality is associated with the 10 years course of mental and physical disorder symptoms and functional impairment in World Trade Center (WTC) responders. WTC-responders have been exposed to a complex array of airborne toxins and extreme psychological trauma [42–44]. Many continue to suffer from persistent and comorbid mental disorders, such as posttraumatic stress disorder (PTSD, prevalence rate 10%) and physical disorders, including respiratory problems (40%) and gastroesophageal reflux disease (GERD, 24%), as well as experience impaired functioning [45–53]. Although correlational evidence does not permit causal inferences, this population presents a valuable opportunity to investigate the role of personality in health sequel of trauma, given that the WTC disaster was a single traumatic event that affected both mental and physical health of responders, and whose health and functional impairment were subsequently tracked for over a decade.

Studies in other samples indicate that personality may play a role in the hallmark WTC problems. For example, high neuroticism and low agreeableness (specifically the hostility facet) are significant pre-trauma vulnerability factors for PTSD [16, 17, 54]. PTSD is also linked with psychoticism domain of personality pathology [55–58]. Therefore, it is plausible that WTC responders with personality traits linked to neuroticism, agreeableness and psychoticism might have more severe PTSD symptoms. Furthermore, low conscientiousness and high neuroticism were identified as significant vulnerability factors for respiratory problems, even when accounting for smoking, physical activity and comorbid chronic diseases such as cardiovascular and psychiatric disorders [59–61]. Neuroticism also contributes to the severity of GERD symptoms [62–64]. This suggests that personality characteristics related to neuroticism and conscientiousness may play a role in the severity of hallmark physical conditions affecting WTC responders. Finally, personality traits, especially high neuroticism and low conscientiousness, have been prospectively implicated in worse physical, mental, social and work functioning [65–69].

Overall, it is plausible that personality contributes to the chronic post-trauma illness and functioning difficulties in WTC responders.

Aims

Using a sample of 536 WTC-responders, the current study used an exploratory approach to investigate whether PID-5 personality domains and facets were associated with initial levels and 10-year trajectories of hallmark WTC-related illness symptoms and functional impairment. Although we explored all possible associations, based on previous studies we hypothesized that (a) negative affectivity, psychoticism and detachment would be independently associated with initial PTSD (b), negative affectivity and disinhibition would be independently associated with initial lower respiratory symptoms (LRS) and both types of functional impairment, and (c) negative affectivity would be associated with initial GERD. Given the scarcity of research on the *course* of post-trauma illness, and of studies using personality *facets*, these two aspects of analyses were exploratory.

Methods

Sample

Participants came from the Long Island site of the WTC Health Program, which monitors over 8,000 WTC responders from Long Island, NY and provides treatment for WTC-related conditions identified in monitoring [70]. The program began in July 2002 with rolling admission. Relevant mental and physical health outcomes were assessed annually. Due to different enrolment dates and attendance at follow-ups, a number of assessments varied across participants with the mean of 5.34 (*SD* = 2.58). The current sample consisted of $N = 532$ responders who completed personality assessment alongside their yearly monitoring assessment visit between February 2012 and September 2014. We oversampled for pathology by targeting responders who received treatment at the program alongside responders who presented for monitoring, thus 430 (80%) responders were in treatment provided by the program. At the time of 9/11, the mean age of the current sample was 40.97 years (*SD* = 9.02), 89% were male and 79% were White. Ethical approval for the study was granted by the Institutional Reviewer Board of Stony Brook University and all participants provided informed consent.

Measures

The PID-5 [39], a 220-item questionnaire with a four-point response scale (0 = very false, 3 = very true), was used to measure 25 personality facets that load onto five higher-order personality domains [39]. Psychometric properties of the PID-5 are well-documented [39, 41], internal consistencies of the facets were generally very high in the current sample (Mean $\alpha = .86$; range = .68–.96) and other reliability statistics also indicated internal consistency (mean inter-item correlation = .47, range = .28–.71; mean McDonald's omega (ω_h) = .78, range = .64–.93).

PTSD symptoms were measured using the Posttraumatic Stress Disorder Checklist-Specific Version [71], a 17-item self-report questionnaire assessing, on a five-point scale (1 = not at all to 5 = extremely), the severity of WTC-related DSM-IV PTSD symptoms in the past month. The scale demonstrates excellent psychometric properties [72–74], had excellent internal consistency in the current sample ($\alpha = .96$) and was reliable (inter-item correlation = .58; McDonald's $\omega_h = .87$).

Lower respiratory symptoms (LRS) were indexed by the composite of four symptoms in the past 4 weeks: shortness of breath, chest tightness, wheezing and regular cough. These questions were derived from standard assessments used in previous studies of WTC responders that also validated the four-item composite [47]. Participants indicated whether or not they experienced each symptom. Internal consistency was adequate ($\alpha = .69$; McDonald's $\omega_h = .64$) and mean inter-item correlation of $r = .36$ indicated that items cohered together, although the number of items was not large enough to achieve high reliability.

Gastroesophageal reflux disease (GERD) symptoms were indexed by the composite of five symptoms in the past 4 weeks: frequent heartburn, reflux into mouth or throat, frequent acid taste in mouth, coughing after lying down and frequent difficulty swallowing, using questions derived from standard assessments [75]. Participants indicated whether or not they experienced each symptom. Internal consistency was good ($\alpha = .70$; McDonald's $\omega_h = .58$), and mean inter-item correlation of $r = .31$ cohered well.

Functional impairment was assessed using a 12-item Short-Form Health Survey [76]. It includes two indices of functional impairment status: mental and physical scales [77]. The mental scale taps vitality, social functioning and role functioning difficulties caused by mental health problems. The physical scale assesses impaired role functioning caused by physical problems, mobility limitations, bodily pain and overall rating of health. Both scales are normed to a general U.S. population mean of 50 and a *SD* of 10; higher scores represent better functioning.

PTSD and LRS symptoms were assessed since the first monitoring visit, whereas tracking of GERD symptoms and functional impairment began at the second visit.

Analytic Approach

Multilevel models were used to investigate the course of each symptom within-person (i.e. all effects were

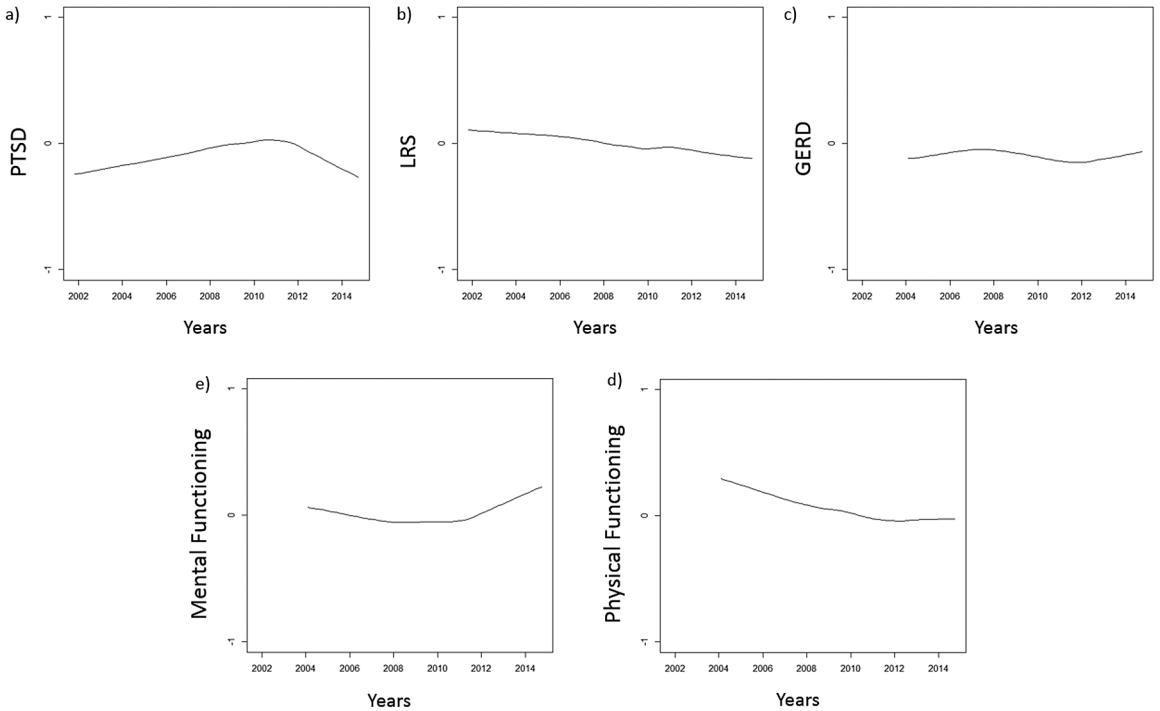

Fig. 1. Course of each symptom and functional impairment from first monitoring visit until the personality assessment estimated by applying a LOESS smoother to all available observations. Notes: PTSD, posttraumatic stress disorder; LRS, lower respiratory symptoms; GERD, gastroesophageal reflux disease symptoms. The y-axis represents scores ±1 *SD* from the sample mean.

specified as random) across the 10-year period starting on the date of each person's first monitoring visit until the final monitoring visit during which the PID-5 was collected. Individual-level random intercepts accounted for variability in baseline symptomatology [78, 79]. Random slopes estimated individual-specific course of symptoms and accounted for heteroscedasticity. We used an unstructured covariance matrix among effects. Missing data has been modeled as missing at random (MAR). Grand mean standardization was used to compute standardized coefficients.

To determine how time should be modeled, we examined overall trajectories—across all data points—of five health outcomes using a LOESS smoother (Fig. 1). For outcomes that exhibited the evidence of a non-linear change with time (PTSD symptoms and mental functional impairment), we fitted multilevel models with a polynomial spline [80]. Multiple splines were tested to identify, based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), a model that best captures any nonlinearity of trajectories. This included models with one segment (no spline), two segments and three segments, and a different linear slope of time within each segment. The model estimated the location of the boundary between segments. Next, we added the month of the first monitoring visit as a between-subject predictor of intercepts and slopes to test whether the date of enrollment affected the models. The time of enrollment had no impact on trajectories, except for a small effect on the LRS intercept ($\beta = -.07$, $p = .04$) and slope ($\beta = -.05$, $p = .04$).

To investigate the role of personality in these trajectories in an exploratory manner, each personality variable entered the model as a between-person predictor of intercepts (initial post-trauma symptom level) and slopes (subsequent illness course). First, we fitted bivariate models to estimate the association between each personality trait (domain or facet) and the trajectory of each outcome. Second, multivariate analyses were conducted to identify the unique associations of multiple personality traits and a given outcome. We modeled five domains together to control for the overlap between domains. Next, we modeled all facets within each domain together to control for the overlap within domains. Given a high number of analyses, we conservatively applied a stringent Bonferroni correction, which for six multivariate analyses resulted in p-value threshold of $p < .0017$ to denote significant effects. All multilevel models were fit using PROC MIXED and PROC GLIMMIX procedure in SAS version 9.2.

Results

Descriptive statistics for all variables are presented in Table 1. The overall course of PTSD and mental functional impairment was best described by a spline model with two segments. PTSD symptoms significantly

Table 1 Descriptive Statistics for Five Health Outcomes (PTSD, LRS, GERD and Mental and Physical Functional Impairment) at First Assessment and PID5 Domains and Facets

	Minimum	Maximum	Mean	*SD*
PTSD	17.00	85.00	35.08	16.76
LRS	0.00	4.00	1.41	1.35
GERD	0.00	5.00	1.15	1.35
Mental functioning	18.24	66.01	45.90	12.15
Physical functioning	14.03	64.32	41.09	12.18
Negative affectivity	0.00	3.00	1.06	0.85
Anxiousness	0.00	3.00	1.10	0.83
Emotional lability	0.00	3.00	0.82	0.77
Hostility	0.00	3.00	0.87	0.71
Perseveration	0.00	2.89	0.62	0.61
Detachment	0.00	3.00	1.10	0.83
Restrictive affectivity	0.00	3.00	0.93	0.66
Separation insecurity	0.00	2.71	0.56	0.65
Submissiveness	0.00	3.00	0.82	0.70
Anhedonia	0.00	3.00	1.06	0.85
Depressivity	0.00	2.79	0.56	0.67
Intimacy avoidance	0.00	3.00	0.54	0.66
Suspiciousness	0.00	2.86	0.89	0.55
Withdrawal	0.00	3.00	0.97	0.88
Antagonism	0.00	2.79	0.56	0.67
Attention seeking	0.00	3.00	0.43	0.54
Callousness	0.00	2.29	0.36	0.38
Deceitfulness	0.00	2.10	0.30	0.37
Grandiosity	0.00	2.83	0.50	0.49
Manipulativeness	0.00	3.00	0.52	0.54
Disinhibition	0.00	3.00	0.82	0.77
Distractibility	0.00	3.00	0.86	0.82
Impulsivity	0.00	3.00	0.67	0.64
Irresponsibility	0.00	2.14	0.36	0.45
Rigid perfectionism	0.00	3.00	0.86	0.68
Risk taking	0.00	2.79	1.21	0.53
Psychoticism	0.00	3.00	0.87	0.71
Eccentricity	0.00	3.00	0.53	0.68
Perceptual dysregulation	0.00	2.58	0.42	0.52
Unusual beliefs	0.00	2.63	0.39	0.52

PTSD, posttraumatic stress disorder; LRS, lower respiratory symptoms; GERD, gastroesophageal reflux disease symptoms. The 30 personality scales were calculated as means of relevant items. PTSD, LRS and GERD items were summed to create a total score. The number of individual observations (% of total number of visits) were PTSD = 2,723 (95%), LRS = 2,660 (93%), GERD = 2,430 (85%), physical functioning and mental functioning = 2,101 (73%) each.

worsened in the first segment (through July of 2011) but then began to improve. The PTSD course is in line with trends previously reported in the whole sample [52]. Mental functioning did not decline significantly in the first segment (through August 2009) but then showed improvement. Linear models with no splines provided the best description of LRS, GERD and physical functional impairment course, indicating a pattern of stability of physical symptoms and a significant decline in physical functioning across the 10-year course. The overall symptom trajectories are presented in Fig. 1, fit statistics for different spline models are in Supplementary Table S1, and the intercept and main effects of time on each trajectory is reported in Supplementary Table S2.

At the domain level, higher negative affectivity was independently associated with higher initial levels of PTSD (β = .20) and worse mental functioning (β = −.20, Table 2), as hypothesized. Higher detachment was also independently associated with initial levels of PTSD, as expected, but also mental functioning (β = .39 and −.43, respectively) and worse physical functioning (β = −.25). Additionally, psychoticism was independently associated with initial levels of PTSD (β = .21), as expected based on previous literature. None of the domains were independently associated with the course of these symptoms, or with the initial level or the course of LRS and GERD. Disinhibition was unrelated to the five illness levels and trajectories. Antagonism emerged as an independent predictor of PTSD and mental functioning, however the direction of the associations indicated a suppression effect. Associations were the opposite of the bivariate estimates (Supplementary Table S3), and none of the antagonism facet results supported the direction of this counterintuitive finding, so we elected not to include it in the summary.

At the level of personality facets, we found remarkably consistent associations of seven personality facets with both initial levels and courses of illnesses. Three personality facets—anhedonia, distractibility and perceptual dysregulation—were independently associated with initial levels of all outcomes (β = .25–.47, .25–.55 and .23–.63, respectively). Two other personality facets were also associated with both mental and physical domains: emotional lability with initial levels of PTSD, LRS and mental functional impairment (β = .22–.33), and callousness with PTSD and mental and physical functional impairment (β = .20–.37). The remaining two facets were only associated with initial levels of psychiatric outcomes: anxiousness with both PTSD and mental functioning (.37–.38), and depressivity only with impaired mental functioning (β = .23). Significant associations between personality domains and facets, and initial levels of symptoms and functional impairment, are summarized on a heatmap (Fig. 2).

Three personality facets were independently associated with the course of illness (Fig. 3)—callousness and perceptual dysregulation were associated with symptom increase during the first segment of PTSD trajectory (β = .07–.10), while anxiousness was associated with smaller improvement in LRS over 10 years (β = .11).

Table 2 The Standardized Estimates and *p* Values for Each Personality Domain and Facet Associated With PTSD, LRS, GERD, and Physical and Mental Functioning Initial Levels and 10-Year Trajectories

	PTSD			LRS			GERD			Mental Functioning			Physical Functioning		
	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI
Domains															
Intercepts															
Negative affectivity	**.20**	**<.001**	(.10, .29)	.10	.071	(−.01, .22)	.15	.009	(.04, .27)	**−.20**	**<.001**	(−.31, −.10)	−.01	.914	(−.14, .12)
Detachment	**.39**	**<.001**	(.29, .49)	.15	.010	(.04, .26)	.11	.051	(.00, .23)	**−.43**	**<.001**	(−.53, −.33)	**−.25**	**<.001**	(−.38, −.12)
Antagonism	**−.18**	**<.001**	(−.25, −.11)	−.12	.007	(−.20, −.03)	**−.14**	**.002**	(−.22, −.05)	**.16**	**<.001**	(.08, .23)	.10	.049	(.00, .20)
Disinhibition	.01	.796	(−.07, .09)	.09	.049	(.00, .19)	−.03	.528	(−.12, .06)	−.07	.075	(−.16, .01)	.03	.526	(−.07, .14)
Psychoticism	**.21**	**<.001**	(.11, .32)	.10	.086	(−.01, .22)	.11	.081	(−.01, .23)	−.06	.289	(−.17, .05)	−.20	.005	(−.34, −.06)
Slopes															
Segment 1 × negative affectivity	.05	.066	(.00, .11)	−.01	.709	(−.07, .05)	−.03	.523	(−.11, .06)	.04	.623	(−.11, .18)	.00	.970	(−.07, .08)
Segment 1 × detachment	.00	.851	(−.05, .06)	.00	.930	(−.05, .06)	−.03	.390	(−.11, .04)	.04	.536	(−.08, .15)	−.05	.190	(−.12, .02)
Segment 1 × antagonism	−.04	.024	(−.08, −.01)	−.04	.038	(−.09, .00)	.03	.270	(−.03, .09)	−.02	.658	(−.13, .08)	−.01	.781	(−.06, .05)
Segment 1 × disinhibition	−.01	.704	(−.05, .03)	−.01	.557	(−.06, .03)	−.05	.123	(−.12, .01)	.00	.982	(−.11, .11)	.00	.948	(−.06, .06)
Segment 1 × psychoticism	.07	.014	(.01, .12)	.06	.057	(.00, .12)	.07	.115	(−.02, .15)	−.12	.141	(−.28, .04)	.07	.068	(−.01, .15)
Segment 2 × negative affectivity	.02	.258	(−.02, .06)							−.03	.331	(−.09, .03)			
Segment 2 × detachment	.02	.347	(−.02, .06)							−.02	.471	(−.08, .04)			
Segment 2 × antagonism	.03	.047	(.00, .06)							−.01	.778	(−.05, .04)			
Segment 2 × disinhibition	−.02	.258	(−.05, .01)							.00	.853	(−.05, .06)			
Segment 2 × psychoticism	−.05	.010	(−.09, −.01)							.02	.573	(−.05, .08)			
Facets															
Intercepts															
Anxiousness	**.37**	**<.001**	(.27, .48)	.13	.032	(.01, .26)	.11	.090	(−.02, .23)	**−.38**	**<.001**	(−.50, −.27)	−.22	.003	(−.36, −.08)
Emotional lability	**.34**	**<.001**	(.23, .45)	**.22**	**<.001**	(.10, .35)	.12	.078	(−.01, .25)	**−.25**	**<.001**	(−.37, −.13)	−.23	.003	(−.37, −.08)
Hostility	−.05	.333	(−.14, .05)	−.04	.449	(−.15, .07)	.02	.763	(−.09, .13)	.02	.646	(−.08, .13)	.06	.335	(−.06, .19)
Perseveration	.07	.183	(−.03, .16)	.04	.455	(−.07, .15)	.01	.815	(−.10, .13)	−.07	.189	(−.18, .04)	.02	.712	(−.10, .15)
Restrictive affectivity	.11	.004	(.03, .18)	.06	.160	(−.02, .15)	.04	.337	(−.04, .13)	−.08	.033	(−.16, −.01)	−.11	.035	(−.21, −.01)
Separation insecurity	−.10	.009	(−.17, −.02)	−.08	.061	(−.17, .00)	−.06	.213	(−.14, .03)	.12	.006	(.04, .21)	.07	.135	(−.02, .17)
Submissiveness	−.08	.029	(−.15, −.01)	.01	.843	(−.07, .09)	.05	.199	(−.03, .14)	.03	.481	(−.05, .11)	.07	.130	(−.02, .17)
Anhedonia	**.42**	**<.001**	(.29, .54)	**.33**	**<.001**	(.19, .48)	**.25**	**<.001**	(.11, .40)	**−.47**	**<.001**	(−.59, −.35)	**−.38**	**<.001**	(−.54, −.21)
Depressivity	**.19**	**<.001**	(.07, .32)	.14	.055	(.00, .28)	.02	.784	(−.13, .17)	**−.23**	**<.001**	(−.35, −.11)	−.09	.275	(−.25, .07)
Intimacy avoidance	.02	.661	(−.07, .10)	−.01	.871	(−.10, .09)	−.08	.127	(−.18, .02)	.05	.265	(−.03, .12)	−.01	.793	(−.12, .09)
Suspiciousness	.02	.525	(−.05, .10)	−.07	.091	(−.15, .01)	−.01	.863	(−.09, .08)	.01	.843	(−.07, .08)	.05	.311	(−.05, .15)
Withdrawal	.06	.317	(−.05, .17)	−.05	.417	(−.18, .07)	.08	.244	(−.05, .21)	−.03	.614	(−.13, .08)	.06	.414	(−.09, .21)
Attention seeking	.03	.644	(−.08, .14)	−.09	.095	(−.19, .01)	−.13	.013	(−.22, −.03)	−.05	.345	(−.16, .06)	.03	.637	(−.09, .14)
Callousness	**.37**	**<.001**	(.27, .46)	.14	.003	(.05, .22)	.10	.023	(.01, .19)	**−.27**	**<.001**	(−.37, −.17)	**−.20**	**<.001**	(−.30, −.11)

	PTSD			LRS			GERD			Mental Functioning			Physical Functioning		
	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI
Deceitfulness	.00	.955	(−.12, .11)	.09	.099	(−.02, .20)	−.05	.395	(−.15, .06)	−.09	.134	(−.21, .03)	.02	.772	(−.10, .14)
Grandiosity	.04	.427	(−.06, .15)	.08	.108	(−.02, .18)	.12	.016	(.02, .22)	.00	.968	(−.11, .11)	−.03	.573	(−.15, .08)
Manipulativeness	−.16	.008	(−.29, −.04)	−.11	.058	(−.22, .00)	−.02	.702	(−.13, .09)	.19	.002	(.07, .32)	.08	.249	(−.05, .20)
Distractibility	**.52**	**<.001**	(.42, .62)	**.27**	**<.001**	(.16, .37)	**.25**	**<.001**	(.15, .35)	**−.55**	**<.001**	(−.65, −.46)	**−.31**	**<.001**	(−.43, −.19)
Impulsivity	.05	.235	(−.03, .14)	.09	.048	(.00, .19)	−.05	.289	(−.14, .04)	−.02	.734	(−.10, .07)	−.06	.312	(−.16, .05)
Irresponsibility	.03	.458	(−.05, .12)	.03	.468	(−.06, .13)	.04	.392	(−.05, .13)	−.01	.892	(−.10, .09)	.03	.631	(−.08, .14)
Rigid perfectionism	.09	.012	(.02, .16)	.00	.929	(−.08, .07)	.07	.058	(.00, .15)	−.05	.170	(−.12, .02)	−.03	.563	(−.11, .06)
Risk taking	−.05	.206	(−.11, .02)	−.06	.101	(−.14, .01)	−.07	.068	(−.14, .01)	.02	.562	(−.05, .09)	.08	.056	(.00, .17)
Eccentricity	.06	.206	(−.04, .16)	−.04	.466	(−.15, .07)	.04	.464	(−.07, .15)	−.06	.231	(−.17, .04)	−.02	.751	(−.14, .10)
Perceptual dysregulation	**.63**	**<.001**	(.51, .74)	**.37**	**<.001**	(.25, .50)	**.24**	**<.001**	(.11, .37)	**−.57**	**<.001**	(−.69, −.45)	**−.37**	**<.001**	(−.51, −.22)
Unusual beliefs	−.08	.147	(−.18, .03)	−.03	.663	(−.14, .09)	−.04	.487	(−.16, .07)	.11	.057	(.00, .23)	.06	.403	(−.08, .19)
Slopes															
Segment 1 × anxiousness	.05	.102	(−.01, .10)	**.11**	**<.001**	(.05, .17)	.02	.646	(−.07, .11)	.04	.603	(−.11, .19)	−.05	.190	(−.14, .03)
Segment 1 × emotional lability	.03	.319	(−.03, .09)	−.09	.008	(−.15, −.02)	.10	.038	(.01, .19)	−.02	.854	(−.19, .15)	.06	.195	(−.03, .14)
Segment 1 × hostility	.05	.027	(.01, .10)	.03	.236	(−.02, .08)	−.08	.037	(−.15, .00)	−.02	.750	(−.15, .11)	−.02	.664	(−.08, .05)
Segment 1 × perseveration	−.07	.009	(−.11, −.02)	−.02	.549	(−.07, .04)	−.03	.398	(−.11, .04)	−.03	.689	(−.17, .12)	.02	.506	(−.05, .10)
Segment 1 × restrictive affectivity	.02	.269	(−.02, .06)	.01	.681	(−.03, .05)	.00	.917	(−.06, .05)	−.02	.728	(−.10, .07)	−.01	.806	(−.06, .05)
Segment 1 × separation insecurity	.05	.024	(.01, .08)	−.01	.532	(−.06, .03)	−.01	.639	(−.07, .05)	−.06	.392	(−.19, .07)	−.01	.768	(−.07, .05)
Segment 1 × submissiveness	−.03	.112	(−.07, .01)	−.04	.100	(−.08, .01)	−.03	.388	(−.08, .03)	.04	.505	(−.07, .14)	.03	.248	(−.02, .09)
Segment 1 × anhedonia	.10	.002	(.04, .17)	.00	.898	(−.07, .08)	−.02	.696	(−.12, .08)	−.09	.234	(−.25, .06)	−.01	.914	(−.10, .09)
Segment 1 × depressivity	.03	.367	(−.03, .09)	.08	.031	(.01, .15)	.04	.433	(−.06, .14)	.05	.496	(−.10, .20)	.04	.376	(−.05, .13)
Segment 1 × intimacy avoidance	−.05	.021	(−.10, −.01)	−.04	.138	(−.08, .01)	−.02	.607	(−.09, .05)	.12	.028	(.01, .22)	−.05	.137	(−.11, .01)
Segment 1 × suspiciousness	−.02	.243	(−.07, .02)	−.03	.119	(−.08, .01)	−.04	.277	(−.10, .03)	.03	.547	(−.07, .14)	−.02	.553	(−.07, .04)
Segment 1 × withdrawal	.01	.801	(−.05, .06)	−.01	.832	(−.07, .06)	−.01	.760	(−.10, .08)	−.10	.125	(−.23, .03)	.02	.584	(−.06, .11)
Segment 1 × attention seeking	.00	.971	(−.04, .05)	−.02	.524	(−.06, .03)	.03	.381	(−.04, .09)	−.02	.752	(−.11, .08)	.01	.724	(−.05, .07)
Segment 1 × callousness	**.07**	**<.001**	(.03, .11)	.02	.473	(−.03, .06)	−.04	.136	(−.10, .01)	−.12	.019	(−.22, −.02)	.00	.920	(−.05, .06)
Segment 1 × deceitfulness	−.04	.097	(−.09, .01)	−.02	.351	(−.08, .03)	.07	.066	(.00, .14)	.10	.118	(−.03, .23)	.00	.962	(−.06, .07)
Segment 1 × grandiosity	.03	.154	(−.01, .08)	.02	.525	(−.03, .07)	.02	.592	(−.05, .08)	−.03	.504	(−.13, .07)	.01	.635	(−.05, .08)
Segment 1 × manipulativeness	−.04	.166	(−.09, .01)	−.01	.754	(−.06, .05)	−.03	.390	(−.10, .04)	−.02	.796	(−.13, .10)	−.02	.656	(−.08, .05)
Segment 1 × distractibility	.06	.014	(.01, .11)	.02	.419	(−.03, .07)	−.04	.221	(−.11, .03)	−.04	.449	(−.15, .07)	−.03	.384	(−.09, .04)
Segment 1 × impulsivity	.00	.989	(−.04, .04)	−.01	.786	(−.05, .04)	.00	.913	(−.06, .07)	.02	.742	(−.09, .12)	.03	.341	(−.03, .09)
Segment 1 × irresponsibility	.01	.579	(−.03, .06)	−.01	.659	(−.06, .04)	.03	.341	(−.03, .10)	−.02	.819	(−.16, .12)	.02	.468	(−.04, .09)
Segment 1 × rigid perfectionism	.03	.119	(−.01, .06)	.02	.333	(−.02, .06)	.01	.577	(−.04, .07)	−.03	.533	(−.12, .06)	.02	.335	(−.03, .07)
Segment 1 × risk taking	−.02	.192	(−.06, .01)	−.01	.559	(−.05, .03)	−.03	.197	(−.08, .02)	−.03	.487	(−.11, .05)	.02	.484	(−.03, .06)
Segment 1 × eccentricity	−.02	.454	(−.07, .03)	.03	.273	(−.02, .08)	−.03	.409	(−.10, .04)	−.12	.046	(−.24, .00)	.02	.620	(−.05, .09)

(Continued)

Table 2 Continued

	PTSD			LRS			GERD			Mental Functioning			Physical Functioning		
	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI	β	*p*	95% CI
Segment 1 × perceptual dysregulation	**.10**	**<.001**	(.04, .16)	−.03	.317	(−.10, .03)	−.01	.757	(−.10, .07)	.07	.279	(−.06, .21)	.06	.168	(−.02, .14)
Segment 1 × unusual beliefs	−.01	.847	(−.06, .05)	.03	.289	(−.03, .09)	.06	.121	(−.02, .14)	−.05	.532	(−.19, .10)	−.04	.312	(−.12, .04)
Segment 2 × anxiousness	.00	.820	(−.04, .05)							−.01	.878	(−.07, .06)			
Segment 2 × emotional lability	−.01	.772	(−.05, .04)							−.01	.766	(−.08, .06)			
Segment 2 × hostility	.00	.886	(−.04, .03)							.01	.796	(−.05, .07)			
Segment 2 × perseveration	−.01	.748	(−.04, .03)							−.05	.137	(−.11, .01)			
Segment 2 × restrictive affectivity	−.01	.567	(−.04, .02)							.03	.231	(−.02, .08)			
Segment 2 × separation insecurity	.01	.457	(−.02, .04)							.00	.937	(−.05, .04)			
Segment 2 × submissiveness	.01	.451	(−.02, .04)							.00	.886	(−.04, .05)			
Segment 2 × anhedonia	−.07	.008	(−.12, −.02)							.05	.190	(−.03, .13)			
Segment 2 × depressivity	.01	.593	(−.04, .06)							−.01	.844	(−.09, .07)			
Segment 2 × intimacy avoidance	−.02	.223	(−.05, .01)							−.02	.564	(−.07, .04)			
Segment 2 × suspiciousness	.04	.019	(.01, .07)							−.04	.135	(−.08, .01)			
Segment 2 × withdrawal	.04	.095	(−.01, .08)							−.04	.329	(−.11, .04)			
Segment 2 × attention seeking	−.01	.404	(−.05, .02)							−.02	.360	(−.08, .03)			
Segment 2 × callousness	.00	.944	(−.03, .03)							−.02	.358	(−.07, .02)			
Segment 2 × deceitfulness	.03	.100	(−.01, .06)							−.06	.034	(−.12, .00)			
Segment 2 × grandiosity	.02	.219	(−.01, .05)							.01	.839	(−.05, .06)			
Segment 2 × manipulativeness	−.01	.532	(−.05, .03)							.06	.059	(.00, .11)			
Segment 2 × distractibility	−.05	.004	(−.09, −.02)							.06	.038	(.00, .11)			
Segment 2 × impulsivity	.03	.126	(−.01, .06)							−.04	.092	(−.09, .01)			
Segment 2 × irresponsibility	.01	.576	(−.02, .04)							−.04	.108	(−.09, .01)			
Segment 2 × rigid perfectionism	.02	.147	(−.01, .04)							−.01	.561	(−.05, .03)			
Segment 2 × risk taking	.00	.935	(−.03, .02)							.01	.678	(−.03, .05)			
Segment 2 × eccentricity	.03	.103	(−.01, .07)							−.02	.458	(−.08, .04)			
Segment 2 × perceptual dysregulation	−.04	.052	(−.09, .00)							−.02	.531	(−.09, .05)			
Segment 2 × unusual beliefs	.00	.966	(−.04, .04)							.02	.480	(−.04, .09)			

PTSD, posttraumatic stress disorder; LRS, lower respiratory symptoms; GERD, gastroesophageal reflux disease symptoms. The results represent six separate multivariate analyses, conducted separately for each of the five health outcomes. First, all personality domains were included together in the model. Second, all facets within each domain were included in the model. The facets comprising each dimension score are as follows: *Negative affectivity*: anxiousness, emotional lability, hostility, perseveration, restricted affectivity, separation insecurity and submissiveness; *Detachment*: anhedonia, depressiveness, intimacy avoidance, suspiciousness and withdrawal; *Antagonism*: attention seeking, callousness, deceitfulness, grandiosity and manipulativeness; *Disinhibition*: distractibility, impulsivity, irresponsibility, rigid perfectionism, risk taking; *Psychoticism*: eccentricity, perceptual dysregulation and unusual beliefs and experiences. Significance threshold was $p < .0017$, using Bonferroni correction for multiple comparisons, significant effects indicated in bold. For this reason 95% CIs should not be interpreted for significance. The gray shading was provided in the manuscript figure, could you please carry it over to the figure in the proofs? Age at 9/11, sex and race were not significantly associated with outcomes, however a trend effect of age on physical functioning intercept was observed ($\beta = -.12$, $p = .003$) that did not meet our significance threshold ($p < .0017$). Adjusting for these variables in the models has not changed the pattern of results.

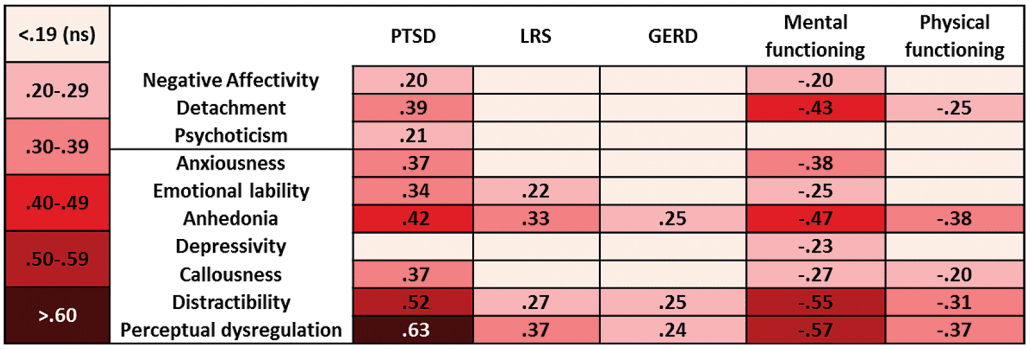

Fig. 2. A heat-map summary of significant associations between personality domains and facets, and initial levels of symptoms and functional impairment. Notes: PTSD, posttraumatic stress disorder; LRS, lower respiratory symptoms; GERD, gastroesophageal reflux disease symptoms.

Discussion

The current study explored associations between all domains and traits of DSM-5 personality structure, and trajectories of mental and physical health. Personality was linked with initial levels of symptoms and functional impairment closely following trauma, as well as their course across 10 years. Narrow facets provided novel and detailed insights into these associations beyond that explained by broad domains. The results suggest novel hypotheses about which traits potentially contribute to health vulnerabilities and trajectories or may explain comorbidity between mental and physical illness. These hypotheses derived from a correlational design can be tested in prospective studies or in randomized clinical trials. Ultimately, present findings may inform development of novel transdiagnostic personality-informed treatments [81–84].

Personality Domains and Initial Health Consequences of Trauma

Broad personality domains had strong associations with mental illness symptoms and functional impairment in the years shortly after 9/11, suggesting that they might constitute important vulnerabilities to trauma, and less robust effects with respect to physical health. As hypothesized, negative affectivity was associated with initial levels of PTSD symptoms and impaired mental functioning, but not to initial physical symptoms or functional impairment. *Negative affectivity* is akin to neuroticism by reflecting a tendency to experience negative emotions and poor coping, and the current results are in line with the previous research which identified neuroticism as a risk factor for psychiatric illness in general [10, 12, 28, 32, 61]. One mechanisms linking negative affectivity to worse PTSD and mental functioning could be heightened sensitivity to negative stimuli, such as biased processing of threat information [85–88]. *Detachment* showed an even more robust association with mental health outcomes as expected, and was also related to physical functioning. Akin to low extraversion, detachment is characterized by low engagement, enthusiasm and confidence, thus results are in line with previous evidence that low extraversion is a risk factor for psychiatric illness and functional impairment [10, 12], possibly because it impacts social interactions, which are crucial protective factors in physical and mental health [89–93]. Finally, as hypothesized, *psychoticism* was associated with initial levels of PTSD. This is consistent with previous work showing that dissociation and even psychotic symptoms are common in PTSD [94–97], as well as past work showing these personality traits are associated with the disorder [55–57]. Contrary to hypotheses, we did not find *disinhibition* domain to contribute to physical health and functioning. Previous findings were based primarily on conscientiousness and appear to have been driven by characteristics specific to conscientiousness. Although disinhibition overlaps with conscientiousness substantially, the former trait includes distinct content [98]. Finally, it is important to note that personality is heritable [99, 100] and shares genetic influences with many aspects of health as well as trauma exposure [101–103], and as such genetic overlap can be one of the mechanisms underpinning common vulnerabilities observed in the current study.

Personality Facets and Initial Health Consequences of Trauma

Facets revealed a more nuanced information about which specific personality characteristics are related to initial illness, potentially constituting vulnerability factors to traumatic events. Seven out of twenty-five personality facets were found to play an independent role in health symptoms and functioning. Five were broadly associated with both mental and physical health, as an initial consequence of the disaster. Anhedonia, distractibility and perceptual dysregulation were associated with all five outcomes. *Anhedonia*, part of the detachment domain, is characterized by the lack of pleasurable experiences in everyday life and an insensitivity to reward, and has

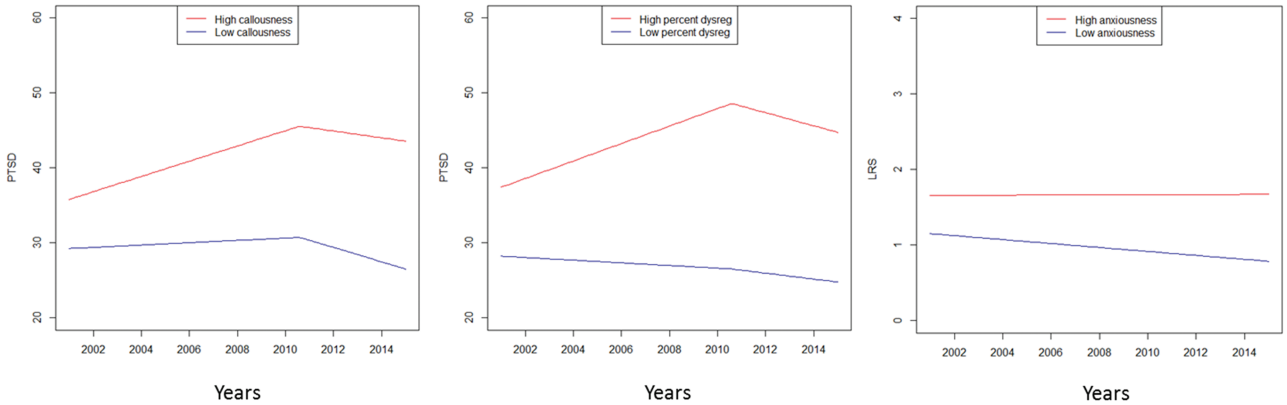

Fig. 3. An illustration of significant associations between personality facets and trajectory of posttraumatic stress disorder (PTSD) symptoms and lower respiratory symptoms (LRS). Notes: Personality domains were analyzed as continuous variables, however for illustrative purposes graphs represents trajectories for ±1 *SD* difference from the mean score for each personality facet. For PTSD, the association between personality facets and trajectories is only significant for the first segment.

been implicated in a range of mental disorders, most importantly PTSD and depression, and is associated with worse functioning [36, 104–107]. Although anhedonia is less studied in the context of physical illness, this trait may be associated with negative health-related behaviors, such as low treatment adherence, and reduction in protective daily activities, such as participation in social engagements, due to reduced motivation [108].

Distractibility belongs to the disinhibition domain and is characterized by a difficulty to remain concentrated and focused on an activity or a goal. Such cognitive deficits were found to predict psychiatric symptoms, including PTSD [109–112], likely because they contribute to maladaptive thought processes involved in the etiology of PTSD, such as rumination, attentional bias to threat and low mindfulness [113–116]. Distractibility may also constitute a vulnerability factor to illness more broadly by interfering with treatment adherence and effective illness management, which can be cognitively demanding.

Perceptual dysregulation, belonging to the psychoticism domain, is a facet underpinned by dissociation and psychotic-like experiences, such as perceptual illusions, derealization, depersonalization, and dissociative amnesia. These traits are commonly observed in trauma survivors, in fact a dissociative subtype of PTSD has been included in the DSM-5 [94, 95, 117] and a dissociation trait predicts future PTSD [58]. Psychoticism (and closely-related schizotypal personality disorder) has been associated with numerous general risk factors for psychopathology that can also impinge on physical health and functioning [118–122], which might explain its associations with all signature WTC disorders. Another explanation for the broad associations between perceptual dysregulation and initial levels of health and functioning problems could be common genetic vulnerability, as genetic overlap had previously been found for perceptual dysregulation, and insomnia and depression symptoms [123, 124].

Emotional liability facet of negative affectivity was associated with initial levels of PTSD, LRS and mental functional impairment. Emotional lability captures a tendency to experience volatile and changeable emotions and is an important component of anxiety disorders, including PTSD [125–127]. Emotional lability might also be associated with LRS by heightened emotions straining sympathetic nervous system responses and in turn exacerbating respiratory symptoms. This is in line with evidence that psychiatric conditions such as PTSD are a risk factor for development of LRS [47].

Callousness, an antagonism facet characterized by a lack of concern for the feelings of others, a lack of guilt and remorse, and an antisocial and aggressive attitude, was associated with initial levels of PTSD, and physical and mental functional impairment. These effects may be explained by negative impact of callousness on social relationships [128–130] and overall life adjustment [131], as well as higher physical health risk associated with aggression, such as cardiovascular illness [6].

Finally, two personality domains anxiousness and depressiveness were only associated with initial psychiatric outcomes. *Anxiousness* facet reflects trait anxiety while *depressiveness* is akin to trait depression, indicating that both personality facets might capture core and chronic vulnerability to internalizing psychopathology, which can increase in severity and manifest as PTSD and mental functional impairment following trauma.

Personality Facets and Illness Course

The current study also investigated the association between personality and the *course* of post-trauma illness, focusing on how personality contributes to the trajectories of illness and functional impairment after accounting for the initial differences in health. In the sample overall, physical functioning declined over 10 years; LRS and GERD symptoms remained steady; PTSD and mental functioning worsened initially consistent with emergence of delayed-onset symptoms [132, 133], but then began to improve. These trajectories might reflect effects of aging, as well as beneficial effects of services that responders receive from the program and their communities, however we were not able to test this in our study (see limitations).

On individual level, personality was associated with differences in slopes of health trajectories, suggesting that personality may shape the illness course [28, 29]. Three personality facets emerged to show a significant and unique association with the illness course. Callousness and perceptual dysregulation were both associated with the increase of PTSD symptoms over the first time segment. *Callousness* reflects insensitivity to others, and may lead to low social support, or inability to engage support to cope with symptoms, which could exacerbate symptoms over time [128–130]. Conflicts and aggressive attitude that characterize callousness also lead to employment, marital and interpersonal problems that can pose psychological strain and worsen the course of PTSD. *Perceptual dysregulation* reflects dissociation and derealization, which may constitute more severe PTSD symptom trajectory [94]. Perceptual dysregulation could also be linked with worse PTSD course by interfering with adaptive interpretation of information, which could be particularly crucial when coping with trauma [134–136]. Finally, although *anxiousness* was unrelated to initial LRS, it was associated with slower decrease in respiratory symptoms. This may reflect the strain of trait anxiety on sympathetic nervous system or immune functioning [137, 138]. Overall, these results point to personality traits as a potential maintenance factors of illness course.

Personality and Mental-Physical Health Comorbidity

Taken together, these results suggest that several aspects of personality—emotional lability, anhedonia, callousness, distractibility and perceptual dysregulation—constitute vulnerability and maintenance factors in both mental and physical health following trauma, implicating personality may play a role in mental-physical comorbidity [5]. PTSD is highly comorbid with LRS and GERD symptoms in WTC-responders, increasing the odds of both disorders (OR = 1.87 and 2.45, respectively) [53]. These problems also frequently co-occur in other trauma-exposed, primary care and general populations [4, 139–141]. Likewise, high comorbidity between LRS and GERD was observed in WTC-exposed populations [45, 53, 142] and in other samples [143, 144]. As such, it is essential to identify modifiable factors that drive this comorbidity. The current results suggest that several personality facets likely underpin mental-physical comorbidity and therefore constitute potential targets for personality-informed treatments [81–84, 145, 146].

Limitations

State-of-the-art personality domain and facet assessment, wide coverage of health that includes both symptoms and functioning across physical as well as mental disorders, and modeling of health trajectories with multiple prospective measurements following a common trauma experience, are considerable strengths of the current study. Nonetheless, the findings are tempered by a number of limitations. First, personality was assessed at the end point of trajectories and the study used a correlational design. Although personality is stable across life [147, 148], especially in middle-aged adults, it could be reversely affected by the experience of chronic illness [149] and for this reason we could not establish personality as a prospective predictor. Future studies should utilize prospective longitudinal design to test predictive effects. It is also important to study mechanisms by which the observed effects might occur, for example the hypothesized role of health behaviors and social support, as well as the extent to which common genetic vulnerabilities account for the association between personality and health outcomes following trauma. Second, the current sample consisted of WTC-responders, enriched for mental and physical disorders to maximize power. The association between personality and initial illness levels and course should be explored in more representative samples, as well as using other conceptualizations of personality structure.

Third, the current study relied on self-reported personality, PTSD symptoms and functional impairment, which might be limited by reporting biases and a shared methods variance. However, LRS and GERD symptoms were assessed by medical professionals using clinical interviews that, together with PTSD symptoms, were highly correlated with clinical diagnoses and certification (polyserial r = .57–.73). Furthermore, the PTSD questionnaire had excellent psychometric properties and showed high agreement with interview ratings of symptoms [52], thus it is unlikely that reporting biases can fully explain the current findings. Nonetheless, future studies could benefit from using multimethod assessments of symptoms and functional impairment. Alternatively, collateral assessment of responders' personality by family members or close friends also is able

to eliminate such biases. Fourth, although age, sex and race were not significantly associated with outcomes and did not affect the results of the study, it is possible that other unmeasured covariates or moderators could have affected the results. For example, we did not control whether and what treatment participants received, and therefore were unable to test the impact of treatment on symptom and functioning trajectories. Given previous studies in WTC samples demonstrating changes in health outcomes following intervention [150], future randomized control trials should explore whether treatment also had impact on personality. Other potential covariates or moderators beyond the scope of the current study include socio-economic status, smoking and comorbid conditions. Finally, we focused on hallmark symptoms of the WTC exposure. Other disasters are linked to different types of health outcomes, and their course needs to be examined in relation to personality as well. We were also unable to determine which symptoms constitute a direct consequence vs are independent of the 9/11 disaster. Nonetheless, previous studies documented a considerable surge in psychiatric and physical illness following 9/11 [45, 46, 49].

Conclusions

The current study is the first to investigate associations between personality and both the initial health problems and the long-term course of health and functioning following trauma. The broad personality domains—negative affectivity, detachment and psychoticism—were uniquely associated with initial PTSD and mental and physical functional impairment. Five narrow facets, including anhedonia, distractibility and perceptual dysregulation, were associated with initial mental and physical problems. Callousness, perceptual dysregulation and anxiousness were associated with worse course of PTSD symptoms and respiratory problems. The results suggest that maladaptive personality may help to explain some of the chronic health problems found in traumatized populations. Adjuvant treatments that address these personality risks may prove to enhance efficacy of existing interventions.

Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

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Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Authors Monika A. Waszczuk, Kaiqiao Li, Camilo J. Ruggero, Sean A. P. Clouston, Benjamin J. Luft, and Roman Kotov declare that they have no conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Compliance with Ethical Standards

Ethical Approval We confirm that ethical approval for the study was granted by the Institutional Reviewer Board of Stony Brook University and all participants provided informed consent.

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