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The impact of trauma core dimensions on anxiety and depression: a latent regression model through the Post-Traumatic Symptom Questionnaire (PTSQ)

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Adverse life events (e.g., severe accidents, violence/abuse, organic disorders) can elicit traumatic responses characterized by intrusive thoughts, hyperarousal, and avoidance—highlighting the need for sound assessment tools. Also, these traumatic components could heighten anxiety and depression symptoms. This study aims included to: (1) assessing the psychometric properties of the Post-Traumatic Symptom Questionnaire (PTSQ) and delineating clinical cut-offs; (2) investigating how distinct trauma components contribute to anxiety and depression symptoms. Involving 761 participants who experienced a traumatic event, Part I tested the PTSQ psychometric properties, defining clinical cut-offs. Part II tested the impact of traumatic components on anxiety and depression symptoms, using a multiple multivariate latent regression model. PTSQ exhibited exemplary fit indices and robust psychometric properties. Clinically relevant cut-offs were identified. The differential contributions of intrusion, avoidance, and hyperarousal to anxiety and depression symptoms were evaluated, elucidating the strength and nature of these relationships. This study reaffirms the PTSQ as a psychometrically sound and reliable instrument. It underscores the effects of intrusion, avoidance, and hyperarousal on anxiety and depression symptoms in individuals with traumatic experiences. These insights advocate for evidence-based interventions aimed at alleviating the psychological suffering associated with trauma components, fostering adaptation and supporting psychological health.

Keywords Traumatic experiences, Post-traumatic stress, PTSD, PTSS, Anxiety, Depression

Traumatic events can disrupt individuals' lives, threatening sense of security and well-being, causing significant harm to individuals and society, resulting in human and economic costs[1,2]. Traumatic events with the associated psychological impact can occur at different life stages either personally or vicariously through third-party experiences, such as witnessing someone else's trauma[3]. Traumatic events encompass a wide range of occurrences (e.g., surviving life-threatening situations, near-fatal injuries, sexual violence, wars, tortures, natural disasters)[4–6]. Additionally, traumatic events can be acute, occurring suddenly, or chronic and prolonged, as seen in cases of neglect, abuse, or enduring life-threatening conditions like cancer[7–9]. Moreover, according to recent literature[10,11], it is important to differentiate between traumatic event(s) and traumatic experience(s). On one hand, a traumatic event is a specific critical episode associated with a major threat or harm to one's sense of integrity. On the other hand, a traumatic experience refers to the individual emotional reaction and psychological response following an event. Noteworthy, this subjective traumatic experience may occur even if the event itself is not considered critical but is appraised as such. By focusing on traumatic experiences rather than just traumatic events, it is

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possible to consider a wider range of situations that may trigger post-traumatic stress symptoms (PTSS) and/or post-traumatic stress disorder (PTSD), beyond the most obvious or severe circumstances[10].

Post-traumatic stress

Experiencing traumatic events has a potentially detrimental effect on mental health: traumatic events are a pivotal risk factor for the development and maintenance of post-traumatic stress symptoms (PTSS) which can lead to various psychological difficulties[2] including post-traumatic stress disorder (PTSD), anxiety and depression symptoms[12,13]. Notably, reactions to traumatic events vary widely, and following exposure to a traumatic event, approximately one-third of individuals experience clinically significant post-traumatic reactions[14,15]. According to a recent review[16], the point prevalence rates of PTSD in the general population varied between 8.0 and 56.7%, the 1-year prevalence rates ranged from 2.3 to 9.1%, and the lifetime prevalence between 3.4 and 26.9%.

In the diagnostic literature, the International Classification of Disease-11 (ICD-11)[17] and Diagnostic Statistic Manual-5 text revised (DSM-5-TR)[11] both share three components/clusters of symptoms of post-traumatic stress: intrusive re-experiencing of the event, avoidance, and hyperarousal[4,18]. The DSM-5-TR also encompasses a fourth component referring to "negative alterations in cognition and mood." However, literature suggests that its exclusion allows for enhanced diagnostic precision concerning symptoms that overlap with other disorders, particularly anxiety and depression symptoms. Additionally, this component may be considered not as a core symptom of PTSD but rather as a consequence of it[19]. Thus, the three components shared by ICD-11 and DSM-5TR can be considered the core symptoms specific to PTSD[20]. Given the importance of differentiating and assessing the trauma components distinctly, recently the Post-traumatic symptoms questionnaire (PTSQ)[13], a new promising self-report questionnaire, was developed and validated to measure with precision the three core components of PTSS and revealed excellent psychometric properties. According to the original development and validation study, the factorial structure for the PTSQ was a hierarchical second-order model, consisting of three first-order factors corresponding to the three dimensions of post-traumatic stress symptoms (i.e., intrusion, avoidance, and hyperarousal), each measured by four items, for a total of 12 items. These three components can be summed to form a second-order general factor of post-traumatic symptoms, with higher scores indicating more severe symptomatology, which demonstrated an excellent fit to the data and optimal internal consistency values[13].

Core trauma components and pathways to adverse psychological consequences

Each of the three core component/symptoms' clusters of the psychological reactions to trauma may lead to adverse psychological symptoms such as anxious and depressive ones[21].

Intrusion is the first cluster of symptoms (or component of PTSD), it is related to a specific form of memory dysfunction and consists of persistent and involuntary reminders of the traumatic experience which make individuals reexperience it, thus triggering intense distress[22]. Intrusiveness occurs along a continuum ranging from the low extreme where memories and thoughts are described as vivid and intrusive to the upper extreme with flashbacks or trauma-related nightmares[23]. A review found that intrusion was positively associated with anxiety[24], possibly because the unwanted adverse memories of the traumatic experience are so vivid and real that one can experience the fear of the event as if it was imminent and the anxiety that it will happen again[22]. Intrusion is also related to depressive symptoms, indeed attributing a negative interpretation and meaning to intrusive memories may lead to ruminative responses (as a form of cognitive avoidance) then leading to increased depressive symptoms[25,26].

Avoidance is the strong and active tendency to suppress or distance the trauma reminders consisting in potential threats and stimuli—both internal (e.g., thoughts, emotions, memories) and external (e.g., places, situations)—related to the traumatic experience[27]. In the short term, avoidance may provide temporary relief from distress but in the long term can hinder the ability to process and heal from the trauma, prolonging symptoms[28]. About the link from avoidance to anxiety, although avoidance represents a strategy for evading feared stimuli in the short-term, it is not effective in the long-term because to cognitively avoid something one has to constantly have that trauma-related stimuli always present in mind, thinking and worrying about that. Thus, avoidance inadvertently activates a threat-monitoring strategy in which the thoughts to avoid become the new threat, and selective attentive processes make threatening stimuli more likely to be detected[29]. Avoidance can also lead to depression because to evade overwhelming trauma-related emotions people may engage in increased avoidance in different ways (emotional, social, and behavioral)[28,30], which in turn, may sustain the development of depressive symptoms[31].

Hyperarousal is the third cluster/component of PTSS/PTSD, referring to a persistent state of increased physiological and psychological arousal following a traumatic experience, characterized by hypervigilance, irritability, and exaggerated startle response[11]. The hyperarousal subtype of PTSD accounts for approximately 70% of cases and evidence from neuroscience and psychiatric findings suggests that the amygdala is a crucial brain region involved in peritraumatic hyperarousal processes and symptoms[32]. Hyperarousal symptoms following a short, sudden natural disaster are more strongly associated with psychopathology and functional impairment than other posttraumatic stress symptoms[33]. Hyperarousal is linked to anxiety through the hyperactivity of the amygdala causing heightened activation of the sympathetic system, involving higher heart rate variability and skin conductance[32]. Hyperarousal can lead to depressive symptoms possibly via its negative effect on interpersonal functioning[34] and/or because is strongly associated with aggressive and impulsive behaviors[35], and suicidality[36].

Research gap and present research

As previously stated, both the clinical and research practice raised the need to accurately evaluate the degree of severity of the three core components of PTSS. However, to date, the psychometric properties of the PTSQ structural validity was only tested in young adults (age range 18–30 years old) and there are not yet cut-off

points for its clinical use. Moreover, despite a growing amount of scientific literature focused on the effects of trauma (in general) on mental health, a smaller amount investigated the relationships of the specific core trauma components—intrusion, avoidance, hyperarousal—with other psychological constructs[33] such as anxiety and depression symptoms, and the role of the three core trauma components is still not clear.

Considering this background, the present research had a two-fold aim. First, it aimed at testing the psychometric properties of the PTSQ defining the clinical cut-offs for the clinical and research practice (Part I) in a large sample of adults with traumatic experiences. Second, it aimed at testing the relationship from the three PTSQ components—intrusion, hyperarousal, avoidance—to anxiety and depression symptoms (Part II).

The following research hypotheses (RH) were formulated:

- RH#1: all the measured constructs—intrusions, avoidance, hyperarousal, anxiety and depression symptoms—are positively related among each other;
- RH#2: each trauma component—intrusions, avoidance, hyperarousal—is positively related with anxiety symptoms—controlling for the other trauma components;
- RH#3: each trauma component—intrusions, avoidance, hyperarousal—is positively related with depression symptoms—controlling for the other trauma components.

Methods

Procedure and Sample size determination

The snowball sampling method[37] was employed to enroll participants from the general population through social media platforms such as Facebook and Twitter. Inclusion criteria involved: (A) having faced at least one traumatic experience, of which a vivid memory is still present; (B) being 18 years or older, (C) being a native Italian speaker, (D) having no impediments to completing the assessment, (E) providing complete responses, and (F) signing a written informed consent. The Study was approved by the Ethics Committee of the University of Padua (protocol n° 114-c).

The sample size was determined a priori on the basis of main statistical analysis (see dedicated section, part II) using the "n:q criterion"[38]—namely, the ratio of the number of participants (n) to the number of model parameters (q). Following guidelines[38,39], a minimum of 10 participants per parameter was enrolled to ensure sufficient statistical power for the proposed model. Consequently, considering that the tested model had 67 parameters, a minimum of 670 participants were guaranteed.

Participants

A sample of 761 participants was enrolled: each reported having faced at least one traumatic experience of which they still have a vivid memory. According to the inclusion/exclusion criteria, none of the observations had missing data. The sample included 194 males (25.5%) and 567 females (74.5%), aged between 18 and 76 years (*mean* = 44.66, *SD* = 12.23). More details are reported in Table 1.

Measures

The presence of traumatic experiences was determined by asking participants to fill out a qualitative list detailing the types of experiences they faced and when (e.g., childhood/adolescence, adulthood). This list is provided in the supplementary materials.

Post-traumatic symptom questionnaire (PTSQ)

The PTSQ[13] is a brief, accurate, solid, and reliable self-report questionnaire consisting of two sections that can be used together and/or independently of each other (see Supplementary Material). The first section includes a checklist (PTSQ-CL; 0 = No; 1 = Yes) that assesses the presence of traumatic experiences during childhood/adolescence and adulthood: higher scores correspond to a greater number of traumatic experiences. The second section includes 12 items designed to assess three core domains associated with the impact of traumatic experiences: (A) intrusivity, (B) avoidance, and (C) hyperarousal. Intrusivity (INTR) assesses the intensity of intrusive thoughts, images, and negative emotions resembling the traumatic experience faced by individuals. Avoidance (AV) evaluates how much individuals steer clear of triggers like situations, people, thoughts, and actions associated with the traumatic incident. Lastly, hyperarousal (HY.AR) quantifies the level of heightened reactions, including hypervigilance, fear, and increased alertness in daily life after a traumatic experience. Participants rate the occurrence of each sentence/symptom using a 5-point Likert scale, ranging from 1 (= "not at all") to 5 (= "extremely") with higher scores indicating greater severity within each domain. Additionally, a total score (*i.e.*, post-traumatic symptoms; PTS) can be computed. In the present study only the second section was used.

Impact of event scale revised (IES-R)

The IES-R[40,41] comprises 22 self-report items designed to assess PTS symptoms in individuals who have experienced a traumatic event. It comprises three different dimensions: hyperarousal, avoidance, and intrusion. It is also possible to calculate a total score. Participants rate each item on a 5-point Likert scale, ranging from 0 (= "not at all") to 4 (= "extremely"). In this study, the IES-R demonstrated good internal consistency across its dimensions and the total score: hyperarousal: McDonald's Omega = 0.908; avoidance: McDonald's Omega = 0.819; intrusion: McDonald's Omega = 0.881, and total score: McDonald's Omega = 0.941.

	(*N* = 761)	
Age (*M. SD*)	44.68	12.23
Sex (*n.* %)		
Male	194	25.5%
Female	567	74.5%
Marital status (*n.* %)		
Single	120	15.8%
In a relationship	188	24.7%
Married	356	46.8%
Separated/divorced	79	10.4%
Widowed	18	2.4%
Education (*n.* %)		
Middle school	119	15.6%
High school	353	46.4%
University	231	30.4%
Ph.D.	58	7.6%
Work status (*n.* %)		
Student	49	6.4%
Full-time worker	320	42.0%
Part-time worker	120	15.8%
Entrepreneur	123	16.2%
Housewife	58	7.6%
Unemployed	39	5.1%
Retired	52	6.8%
Traumatic event (*n.* %)		
Tragic loss of a beloved one	258	33.9%
Serious accidents (e.g., domestic and/or automobile)	187	24.6%
Serious illnesses	177	23.3%
Physical abuse	55	7.2%
Psychological abuse	158	20.7%
Sexual abuse and/or sexual harassment	85	11.1%
Undergone bullying	29	3.8%
Witnessing traumatic event	277	36.3%
Other	204	26.8%

Table 1. Samples's descriptive statistics.

Post-traumatic stress disorder checklist for DSM 5 (PCL-5)
The PCL-5[42,43] is a self-reported assessment tool designed for screening PTSD. Comprising 20 items, the PCL-5 delineates symptoms of PTSD based on the DSM-5. Respondents evaluate the extent to which each item has affected them over the past month using a 5-point Likert scale ranging from 0 (="not at all") to 4 (="extremely")—higher scores reflect the presence and severity of PTSD symptoms. In this study, the PCL-5 showed good internal consistency: McDonald's Omega = 0.956.

Generalized anxiety disorder 7 (GAD-7)
The GAD-7[44,45] is a questionnaire evaluating physical, cognitive, and psychological manifestations of anxiety. It comprises 7 items and respondents rate the frequency and the severity of their symptoms on a 4-point Likert-type scale ranging from 0 (="never") to 3 (="almost every day"), with higher scores indicating greater presence and severity of anxiety. In this study, the GAD-7 exhibited good internal consistency value: McDonald's Omega = 0.891.

Patient health questionnaire 9 (PHQ-9)
The PHQ-9[46,47] is a self-report measure aimed at assessing somatic, cognitive, and emotive facets of depression. It comprises 9 items and respondents rate the frequency and the severity of their symptoms on a 4-point Likert-type scale ranging from 0 (="never") to 3 (="almost every day"), with higher scores indicating greater presence and severity of depression. In this study, the PHQ-9 showed good internal consistency values: McDonald's Omega = 0.870.

Statistical analysis

Statistical analyses were performed using the software R.

Considering the *first objective of this study*, the structural validity of the PTSQ was assessed through confirmatory factor analysis (CFA). In line with the original validation study[13] a second-order factorial structure with three first order factors and one general factor was specified. The Diagonally Weighted Least Squares (DWLS) estimator was used[38,39]. Model fit was evaluated using traditional goodness-of-fit indices (S-Bχ^2, RMSEA, CFI, SRMR) and adhered to recommended cutoff values: (A) non-significant χ^2, (B) RMSEA below 0.08, (C) CFI exceeding 0.95, and (D) SRMR below 0.08. Internal consistency of the PTSQ was assessed with McDonald's omega[48]. Item-total correlation (adjusted) and Pearson correlation coefficient were calculated to evaluate convergent validity—interpreted using Cohen's benchmarks[49]: $r < 0.10$, trivial; r from 0.10 to 0.30, small; r from 0.30 to 0.50, moderate; $r > 0.50$, large. Moreover, overall accuracy and validity of the PTSQ were evaluated using the area under the ROC curve (AUC; 5000 stratified bootstrap resamples)—interpreted using Swets' benchmarks[50]: AUC = 0.50, null; AUC from 0.51 to 0.70, small; AUC from 0.71 to 0.90, moderate; AUC from 0.91 to 0.99, large; and AUC = 1.00, indicating perfect accuracy. Additionally, sensitivity, specificity, and accuracy of the PTSQ were examined against the two gold standard questionnaires measuring PTSS and PTSD—respectively, IES-R and PCL-5.

To achieve the *second objective of this study*, several phases were run. *First*, before carrying out the main analyses of the study, preliminary analyses were performed to assess the intensity of the relationships between the observed variables[51]. Also, model assumptions were tested and no violations were detected[38,51] (see Supplementary material). *Second*, the measurement model of each scale was evaluated to confirm that the structural validity of the questionnaires had a good fit to the data—using fit indices (i.e., χ^2, RMSEA, CFI, SRMR) and their recommended cutoff values[38,39]. *Third*, the common method bias was tested[52]. *Fourth*, a multiple-multivariate regression model with latent variables (MMLR model) was specified. In detail, the three components (namely, INRT, AV and HY.AR, respectively, X1, X2, and X3) delineating the impact of traumatic experiences were regressed on anxiety (Y1) and depression (Y2) symptoms (see Fig. 1). *Fifth*, latent factors of the MMLR model were defined by using parcels as indicators to obtain more precise and robust estimates of the effects[53,54] and research indicates that parceling methods are superior to alternative approaches. Indeed, parcels are more reliable and less likely to violate assumptions (e.g., normality)[53,54], minimize the risk of excessive statistical power[55], exhibit a higher ratio of common-to-unique variance, reduce sampling error, decrease the number of freely estimated parameters, and limit the need for specifying cross-loadings or correlated error variances[53,54]. Considering the three components of the PTSQ (i.e., INRT, AV, and HY.AR), a fully disaggregated approach was chosen—due to the low number of items—while for the GAD-7 and the PHQ-9 a partially disaggregated item-parcel approach was chosen, relying on an item-to-construct balance strategy. *Sixth*, to carry out the MMLR model, the maximum likelihood (ML) estimator was used with a 10,000 bootstrap resampling procedure with the Bollen–Stine method to deal with non-perfect normality of parcels. Even in this case, model fit was assessed with the χ^2 test, the RMSEA, the

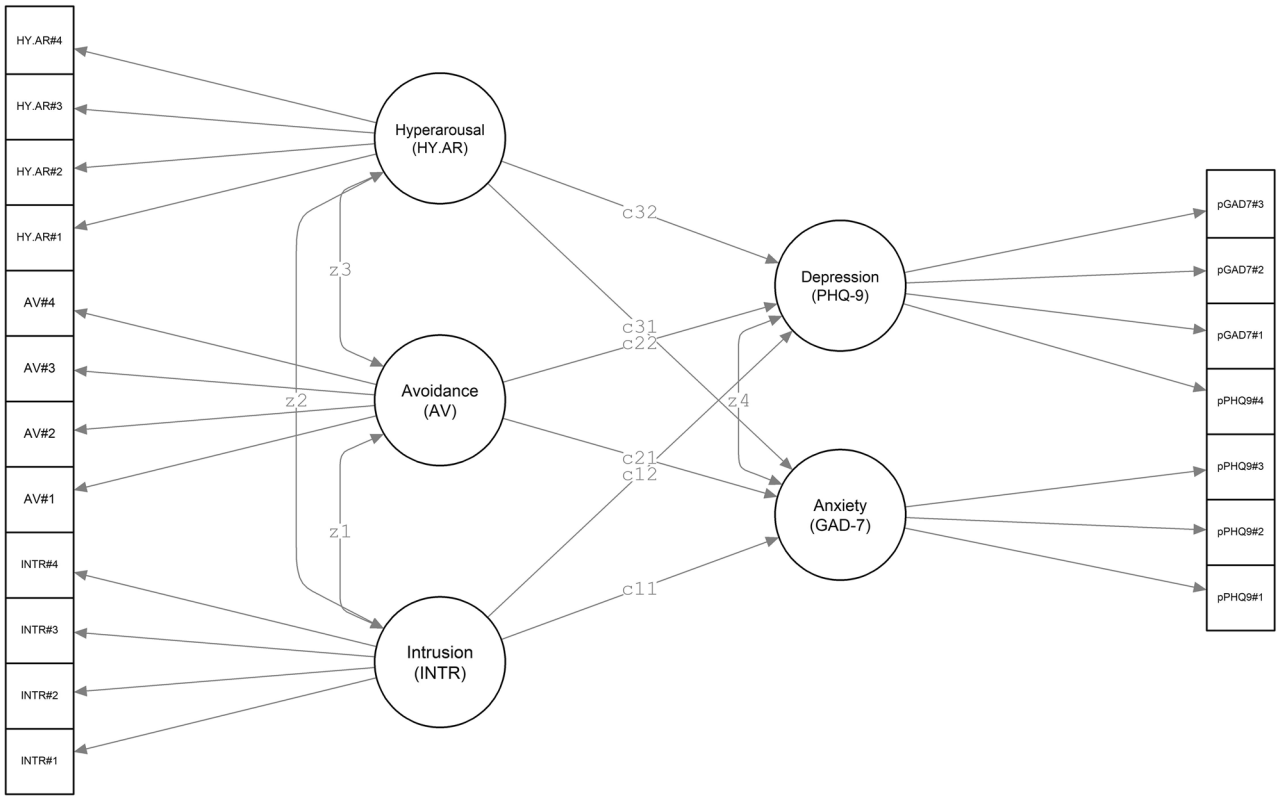

Fig. 1. Multiple-multivariate latent regression (MMLR) model-conceptual representation.

CFI, and the SRMR and their recommended cutoff values[38,39]. All regression coefficients reported in the results section were unstandardized (B). As a supplementary analysis, the difference of the strength of the associations between predictors and outcomes was evaluated by comparing the standard density bootstrap distributions (10,000 replications) of the standardized regression coefficients (β). This was done using the separation index (1-η)[56,57] measuring the magnitude (effect size) of the difference of a phenomenon[56,58]. The 1-η-index ranges from 0 (indicating perfect overlap) to 1 (indicating perfect separation) and should be interpreted similarly to other normalized effect sizes (e.g., correlation, R^2, percentages)[56]. The study was in accordance with the ethical standards of the Ethical Committee of the University of Padua – protocol n° 114-c.

Results

Part I: psychometric properties of the PTSQ

PTSQ Structural validity

In line with the original validation study, a second order model was tested: a general latent factor (called: 'Post traumatic symptoms') loaded onto three different first-order latent factors (*i.e.*, Intrusion, Avoidance, and hyperarousal); moreover, each of these latent factors loaded onto four different indicators. This model showed a good fit to the data. Despite the statistically significant χ^2 statistic [S-Bχ^2 (51) = 220.925; $p < 0.001$], the other fit indices showed a good fit to the data: RMSEA = 0.066; 90%CI: 0.057–0.075; p(RMSEA < 0.05) = 0.001, the CFI = 0.996, the SRMR = 0.046. First order items' loadings ranged from 0.706 (item#7, $R^2 = 0.498$; Avoidance) to 0.934 (item#2, $R^2 = 0.872$; Intrusion). Moreover, second order loadings ranged from 0.533 ($R^2 = 0.284$; Avoidance) to 0.997 ($R^2 = 0.995$; Hyperarousal)—Table 2.

Internal consistency and convergent validity

Internal consistency analysis revealed satisfying results: for the INTR subscale, omega was 0.920, for the AV subscale omega was 0.831, for the HY.AR subscale, omega was 0.850, and for the PTS scale, omega was 0.875.

As reported in Table 3, the PTSQ total score was strongly associated with self-report questionnaires measuring the impact of the traumatic event (IES-R; $r = 0.856$, $p < 0.001$) and the presence of post-traumatic stress symptoms (PCL-5; $r = 0.685$, $p < 0.001$). Moreover, high correlations were found between the subscales of the PTSQ and the subscales of the IES-R measuring the same dimension: the correlation between the PTSQ INTR subscale and IES-R intrusion subscale was $r = 0.808$, $p < 0.001$; the correlation between the PTSQ AV subscale and IES-R avoidance subscale was $r = 0.754$, $p < 0.001$; the correlation between the PTSQ HY.AR subscale and IES-R hyperarousal subscale was $r = 0.752$, $p < 0.001$.

Accuracy of the PTSQ as a screening tool and identification of clinical cut-off

Using the IES-R cutoff for post-traumatic stress symptoms (IES-R ≤ 32 vs. IES-R ≥ 33), the PTSQ total score (i.e., post-traumatic stress, PTS) demonstrated excellent accuracy in distinguishing between participants with and without post-traumatic stress symptoms: AUC (large) = 0.923, 95%CI [0.905, 0.941]. Using a PTSQ cutoff of 32 (PTS ≥ 32), the ROC curve indicated a sensitivity of 0.913, 95%CI [0.885, 0.939], specificity of 0.732,

	Descriptive statistics				Properties	Confirmatory factor analysis	
	M	SD	SK	K	Adj. $r_{it\text{-}tot}$	λ	R^2
Item#1	3.49	1.097	− 0.455	− 0.292	0.769	0.850	0.722
Item#2	3.22	1.059	− 0.252	− 0.377	0.853	0.934	0.872
Item#3	3.15	1.125	− 0.158	− 0.691	0.845	0.922	0.850
Item#4	2.93	1.112	0.054	− 0.686	0.792	0.881	0.777
Item#5	2.64	1.232	0.227	− 0.914	0.633	0.850	0.723
Item#6	2.59	1.321	0.278	− 1.112	0.673	0.798	0.636
Item#7	2.60	1.355	0.369	− 1.072	0.582	0.706	0.498
Item#8	2.59	1.189	0.274	− 0.805	0.746	0.823	0.677
Item#9	2.58	1.200	0.361	− 0.725	0.654	0.783	0.614
Item#10	2.36	1.176	0.507	− 0.687	0.649	0.769	0.591
Item#11	2.76	1.236	0.145	− 0.899	0.778	0.886	0.786
Item#12	2.88	1.174	− 0.087	− 0.779	0.651	0.778	0.605
Intrusion	12.78	3.942	− 0.332	− 0.192	0.569	0.736	0.542
Avoidance	10.42	4.147	0.112	− 0.808	0.412	0.533	0.284
Hyperarousal	10.57	3.959	0.160	− 0.535	0.649	0.997	0.995
Post– Traumatic Symptoms	33.77	9.639	− 0.378	0.009	–	–	–

Table 2. Descriptive statistics, item-total correlation, and confirmatory factor analysis. *M* Mean, *SD* Standard deviation, *SK* Skewness, *K* Kurtosis, *Adj.* $r_{it\text{-}tot}$ adjusted Item-total correlation, *λ* standardized factor loading, R^2 explained variance.

		Descriptives statistics		Correlations										
		M	SD	1	2	3	4	5	6	7	8	9	10	11
1	PTSQ-Post-Traumatic Symptoms	33.77	9.639	–										
2	PTSQ-Intrusion	12.78	3.942	.813	–									
3	PTSQ-Avoidance	10.42	4.147	.736	.326	–								
4	PTSQ-Hyperarousal	10.57	3.959	.854	.641	.421	–							
5	IES-R-Total score	36.52	18.781	.856	.737	.591	.733	–						
6	IES-R-Intrusion	14.46	7.745	.789	.808	.410	.686	.928	–					
7	IES-R-Avoidance	12.17	6.811	.754	.500	.754	.548	.851	.645	–				
8	IES-R-Hyperarousal	9.89	6.279	.771	.665	.443	.752	.923	.844	.664	–			
9	PCL-5	23.30	17.652	.685	.568	.422	.660	.748	.693	.576	.759	–		
10	GAD-7	9.05	5.373	.481	.430	.236	.497	.536	.525	.356	.569	.683	–	
11	PHQ-9	8.83	5.946	.480	.407	.281	.468	.532	.493	.385	.566	.743	.733	–

Table 3. Correlations among measures. All correlations are statistically significant with $p < .001$.

95%CI[0.687, 0.780], and an accuracy of 0.833, 95%CI [0.807, 0.858]. Using the cutoff score for the PTSQ (≥ 32), 32.33% of individuals ($n = 246$) were accurately classified as "true negative" and 50.98% ($n = 388$) as "true positive", resulting in an overall correct classification rate of 83.31%. Conversely, 4.86% were identified as "false negative" ($n = 37$) and 11.83% as "false positive" ($n = 90$) resulting in a total misclassification rate of 16.69%.

Using the PCL-5 cutoff for post-traumatic stress disorder (i.e., PTSD) (PCL-5 ≤ 32 vs. PCL-5 ≥ 33), the PTSQ total score (i.e., post-traumatic stress, PTS) demonstrated high accuracy in distinguishing between participants without risk of PTSD and those with higher risk of PTSD: AUC (moderate-high) = 0.845, 95%CI [0.817, 0.873]. Using a PTSQ cutoff of 36 (≥ 36), the ROC curve indicated a sensitivity of 0.815, 95%CI [0.762, 0.863], specificity of 0.717, 95%CI[0.676, 0.755], and an accuracy of 0.746, 95%CI[0.713, 0.777]. Using the cutoff score for the PTSQ (≥ 36), 50.33% of individuals ($n = 383$) were accurately classified as "true negative" and 24.31% ($n = 185$) as "true positive", resulting in an overall correct classification rate of 74.64%. Conversely, 5.51% were identified as "false negative" ($n = 42$) and 19.84% as "false positive" ($n = 151$) resulting in a total misclassification rate of 25.35%.

Part II: a multiple-multivariate latent regression model

Preliminary analysis

The correlation analyses indicated varying degrees of association, ranging from small to large, among the psychological variables implicated in the MMLR model (Table 3).

Measurement models

As previously shown, the PTSQ revealed adequate goodness-of-fit indices (see section "PTSQ Structural validity"). Also, the GAD-7 scale showed adequate goodness-of-fit indices: S-B$\chi^2(14) = 46.485$; $p < 0.001$; RMSEA = 0.055; 90%CI[0.038, 0.073]; p(RMSEA < 0.05) = 0.285 ns, CFI = 0.999, SRMR = 0.032. Lastly, the PHQ-9 showed adequate fit indices: S-B$\chi^2(27) = 92.754$; $p < 0.001$; RMSEA = 0.057; 90%CI[0.044, 0.069]; p(RMSEA < 0.05) < 0.181 ns, CFI = 0.995, SRMR = 0.046.

Harman's single-factor test

The common method bias has not found empirical verification. The correlated factors model provided adequate fit indices: χ^2 (340) = 752.732; $p < 0.001$; RMSEA = 0.040; 90%CI[0.036, 0.044]; p(RMSEA < 0.05) = 1 ns, CFI = 0.996, SRMR = 0.043. On the contrary, the single-factor model provided poor fit indices: χ^2 (350) = 10,026.293; $p < 0.001$; RMSEA = 0.191; 90%CI[0.188, 0.194]; p(RMSEA < 0.05) < 0.001, CFI = 0.914, SRMR = 0.145. Model comparison showed the absence of the 'common method bias': $\Delta\chi^2$ (10) = 9273.6, $p < 0.001$; |ΔRMSEA| = 0.151, and |ΔCFI| = 0.083.

Multiple-multivariate latent regression model with parcels indicators

Each parcel showed a statistically significant relationship with the designated latent factor, with a standardized factor loading exceeding the optimal threshold of 0.5—specifically, they varied from a minimum of 0.722 to a maximum of 0.903 (Table 4).

The MMLR model (Figs. 1 and 2) provided good fit indices: χ^2 (142) = 408.612; $p < 0.001$; RMSEA = 0.050; 90%CI[0.044, 0.055]; p(RMSEA < 0.05) < 0.528 ns, CFI = 0.972, SRMR = 0.040 (Table 5).

The three core components of the impact of traumatic experiences—INTR (X1), AV (X2), and HY.AR (X3)—were positively associated with each other. In particular, the relationship between INTR (X1) and AV (X2) was: B = 0.338 (SE = 0.040) [95%CI: 0.257; 0.414], z = 8.477, $p < 0.001$. Moreover, the relation between INTR (X1) and HY.AR (X3) was: B = 0.709 (SE = 0.025) [95%CI: 0.659; 0.755], z = 28.914, $p < 0.001$. Lastly, the association between AV (X2) and HY.AR (X3) was: B = 0.483 (SE = 0.036) [95%CI: 0.410; 0.551], z = 13.518, $p < 0.001$. In addition,

	Descriptives statistics				Confirmatory factor analysis			
	M	SD	Sk	K	λ(se)	*z*-value	λ β	R^2
Intrusion (X1)								
Intrusion#1	3.49	1.097	− 0.455	− 0.292	0.889 (0.033)	27.083	0.812	0.659
Intrusion#2	3.22	1.059	− 0.252	− 0.377	0.956 (0.028)	33.631	0.903	0.816
Intrusion#3	3.15	1.125	− 0.158	− 0.691	1.003 (0.029)	34.545	0.893	0.797
Intrusion#4	2.93	1.112	0.054	− 0.686	0.933 (0.029)	32.261	0.839	0.704
Avoidance (X2)								
Avoidance#1	2.64	1.232	0.227	− 0.914	0.890 (0.037)	24.352	0.723	0.523
Avoidance#2	2.59	1.321	0.278	− 1.112	1.032 (0.037)	28.201	0.782	0.612
Avoidance#3	2.60	1.355	0.369	− 1.072	0.882 (0.041)	21.279	0.651	0.424
Avoidance#4	2.59	1.189	0.274	− 0.805	0.982 (0.034)	29.151	0.827	0.684
Hyperarousal (X3)								
Hyperarousal#1	2.58	1.200	0.361	− 0.725	0.869 (0.037)	23.531	0.725	0.525
Hyperarousal#2	2.36	1.176	0.507	− 0.687	0.849 (0.037)	22.960	0.722	0.522
Hyperarousal#3	2.76	1.236	0.145	− 0.899	1.066 (0.030)	36.059	0.863	0.745
Hyperarousal#4	2.88	1.174	− 0.087	− 0.779	0.876 (0.037)	23.642	0.747	0.558
Anxiety (Y1)								
pGAD7#1	1.03	0.818	0.728	− 0.163	0.588 (0.022)	26.606	0.874	0.764
pGAD7#2	1.31	0.897	0.461	− 0.743	0.621 (0.023)	27.459	0.843	0.710
pGAD7#3	1.45	0.814	0.297	− 0.724	0.591 (0.020)	29.775	0.883	0.779
Depression (Y2)								
pPHQ9#1	1.18	0.836	0.514	− 0.492	0.561 (0.021)	26.783	0.801	0.641
pPHQ9#2	0.75	0.765	1.019	0.474	0.513 (0.021)	24.493	0.799	0.639
pPHQ9#3	1.05	0.805	0.611	− 0.284	0.541 (0.021)	26.303	0.802	0.643
pPHQ9#4	0.95	0.680	0.921	0.520	0.493 (0.019)	26.137	0.865	0.748

Table 4. Multiple-multivariate latent regression (MMLR) model-item parcels' statistics. *M* mean, *SD* standard deviation, *Sk* Skewness, *K* Kurtosis, *λβ* standardized factor loading, R^2 explained variance, *p(…)* item parcel, *Intrusion* Intrusion subscale of PTSQ, *Avoidance* Avoidance subscale of PTSQ, *Hyperarousal* Hyperarousal subscale of the PTSQ, *Anxiety* GAD-7, *Depression* PHQ-9.

the two outcomes (Y1 and Y2) were positively associated with each other: B = 0.739 (SE = 0.026) [95%CI: 0.686; 0.789], z = 28.011, $p < 0.001$.

Controlling for AV and HY.AR, the *first* component, INTR (X1) was positively associated with anxiety symptoms (Y1), *path* c11: B = 0.171 (SE = 0.069) [95%CI: 0.035; 0.306], z = 2.469, $p = 0.014$. At the same time, INTR (X1) was positively associated with depression symptoms (Y2), *path c12*: B = 0.173 (SE = 0.068) [95%CI: 0.039; 0.307], z = 2.529, $p = 0.011$.

However, controlling for INTR and HY.AR, the *second* component, AV (X2) was not associated with anxiety symptoms (Y1), *path* c21: B = − 0.013 (SE = 0.057) [95%CI: − 0.127; 0.094], z = − 0.237, $p = 0.813$ ns. Moreover, AV (X2) was not associated with depression symptoms (Y2), *path c22*: B = 0.097 (SE = 0.054) [95%CI: − 0.009; 0.200], z = 1.800, $p = 0.072$ ns.

Lastly, controlling for INTR and AV, the *third* component, HY.AR (X3) was positively associated with anxiety symptoms (Y1), *path c13*: B = 0.565 (SE = 0.085) [95%CI: 0.409; 0.744], z = 6.659, $p < 0.001$. At the same time, HY.AR (X3) was positively associated with depression symptoms (Y2), *path c23*: B = 0.461 (SE = 0.084) [95%CI: 0.305; 0.635], z = 5.522, $p < 0.001$.

The degree of explained variance was 32.3% ($R^2 = 0.323$) for anxiety symptoms and 29.6% ($R^2 = 0.296$) for depression symptoms.

Separation index

The separation index (1-η) revealed small-to-large differences between the estimated densities of the standardized regression coefficients (Fig. 3). In particular, a negligible difference emerged when comparing the effects of intrusions on anxiety symptoms (path c11) and on depression symptoms (path c12): 1-η = 2.8%. Differently, a moderate difference appeared when comparing the effects of hyperarousal on anxiety symptoms (path c31) and on depression symptoms (path c32): 1-η = 46.0%.

Discussion

Given the severe impact of trauma on mental health, it is essential to assess it both in clinical contexts to provide and plan prompt psychological interventions and in research contexts to account for its effects on other constructs. The present research aimed at testing the psychometrics properties of the PTSQ, defining clinical cut-offs, and testing the relationship from the three trauma components to anxious and depressive symptoms.

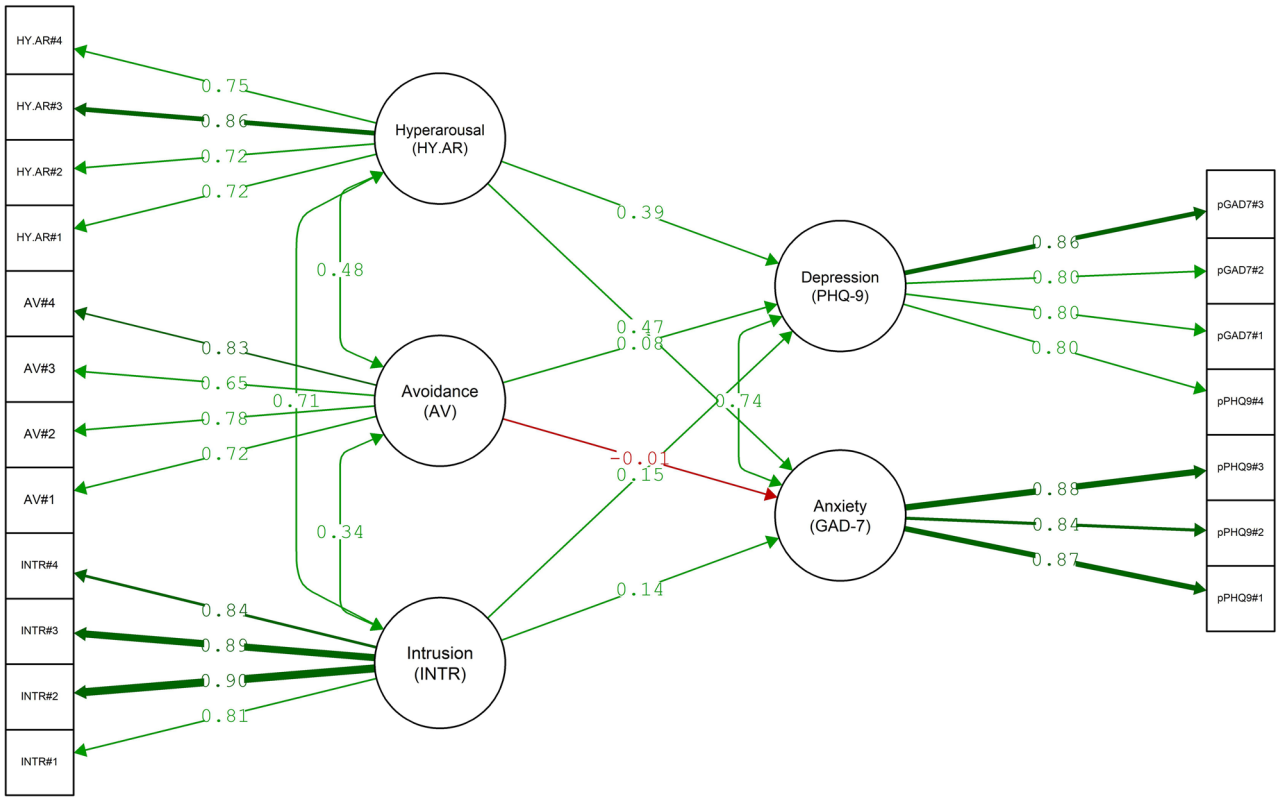

Fig. 2. Results of the multiple-multivariate latent regression (MMLR) model (standardized regression coefficients).

Path		β	B (SE)	95%CI [L—U]	*z-value*	*p*-value	R^2
Intrusion (X1) → Anxiety (Y1)	(c11)	0.141	0.171 (0.069)	[0.035; 0.306]	2.469	.014	
Avoidance (X2) → Anxiety (Y1)	(c21)	− 0.011	− 0.013 (0.057)	[− 0.127; 0.094]	− 0.237	.813	
Hyperarousal (X3) → Anxiety (Y1)	(c31)	0.465	0.565 (0.085)	[0.409; 0.744]	6.659	< .001	0.323
Intrusion (X1) → Depression (Y2)	(c12)	0.145	0.173 (0.068)	[0.039; 0.307]	2.529	.011	
Avoidance (X2) → Depression (Y2)	(c22)	0.081	0.097 (0.054)	[− 0.009; 0.200]	1.800	.072	
Hyperarousal (X3) → Depression (Y2)	(c32)	0.387	0.461 (0.084)	[0.305; 0.635]	5.522	< .001	0.296
Intrusion (X1) ↔ Avoidance (X2)		0.338	0.338 (0.040)	[0.257; 0.414]	8.477	< .001	
Intrusion (X1) ↔ Hyperarousal (X3)		0.709	0.709 (0.025)	[0.659; 0.755]	28.914	< .001	
Avoidance (X2) ↔ Hyperarousal (X3)		0.483	0.483 (0.036)	[0.410; 0.551]	13.518	< .001	
Depression (X1) ↔ Anxiety (Y1)		0.739	0.739 (0.026)	[0.686; 0.789]	28.011	< .001	

Table 5. Results of the multiple-multivariate latent regression (MMLR) model. β = standardized beta; B = unstandardized beta; 95%CI = 95% confidence intervals for the unstandardized beta; R^2 = explained variance. Intrusion = Intrusion subscale of PTSQ; Avoidance = Avoidance subscale of PTSQ; Hyperarousal = Hyperarousal subscale of the PTSQ; Anxiety = GAD-7; Depression = PHQ-9.

Discussion of Part I

Findings of Part I confirmed that the PTSQ has strong psychometric properties and once again confirmed through CFA its internal factor structure based on a hierarchical model with one general factor and three first order components, with excellent fit and internal consistency[13].

Importantly, results from Part I successfully identified the optimal clinical cut-offs of the PTSQ as a screening tool for PTSS and PTSD. The PTSQ was compared with two gold standard tools, the IES-R assessing the components of post-traumatic symptoms and the PCL-5 assessing the risk of PTSD[50].

Comparing the PTSQ with the IES-R, it was suggested a cut-off score of 32 (PTSQ total score ≥ 32) indicating moderate-severe symptomatology requiring clinical attention and a possible PTSD diagnosis to be confirmed after careful clinical evaluation. Considering the IES-R, the AUC was very high with optimal values and a good classification ability, there is also high sensitivity (ability to identify positive cases, what is needed for a screening test as this one) and good specificity (ability to identify negative cases), and satisfactory accuracy[50]. A cutoff value

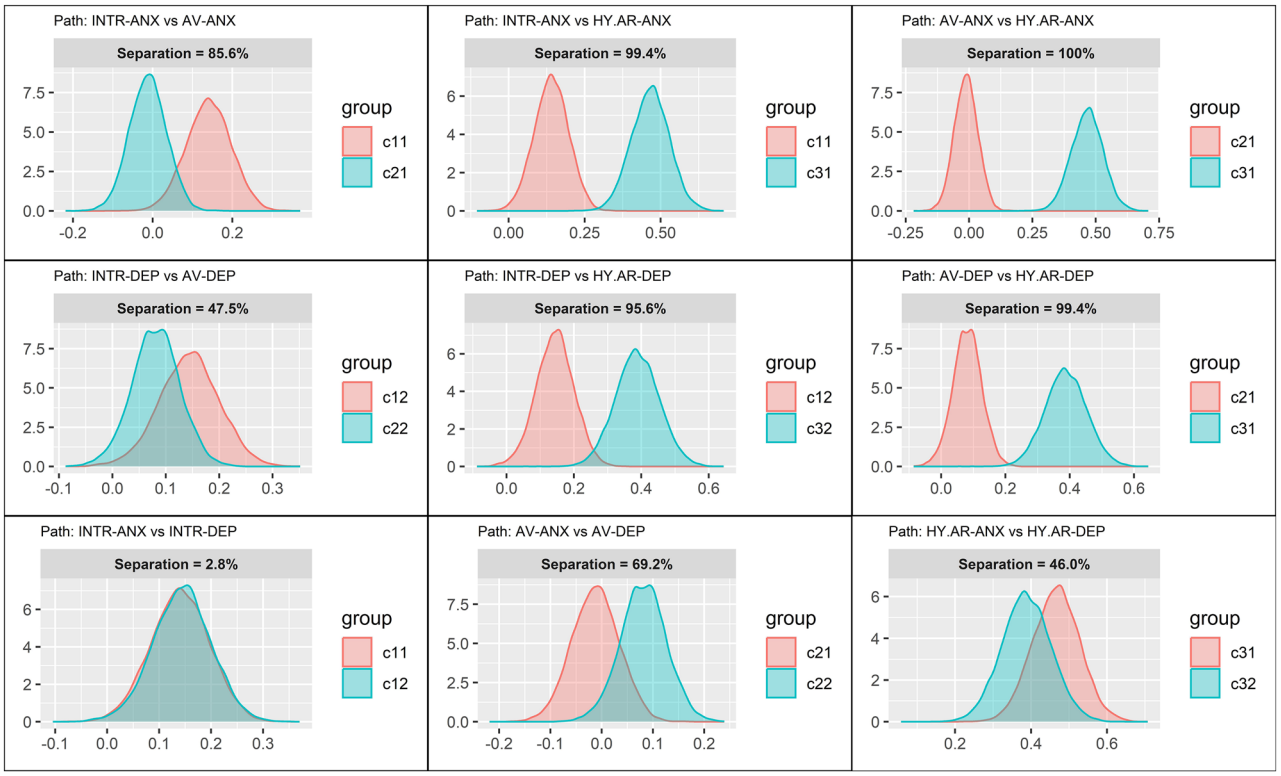

Fig. 3. Results of the standardized regression coefficients comparisons (separation index) via bootstrapped kernel density distribution.

emphasizing a high sensitivity was chosen because the PTSQ is a screening questionnaire designed to identify all the individuals who may have high PTSS. The very high correlation between IES-R and PTSQ ($r = 0.856$) suggested they are measuring the same construct as their correlation exceeds the critical threshold[51,59,60], but the PTSQ does it with a lower number of items, supporting the PTSQ high precision.

Comparing the PTSQ with the PCL-5, a cutoff of ≥ 36 (PTSQ total score ≥ 36) indicated a higher risk of PTSD. With the PCL-5, the AUC was moderate-high and the sensitivity, specificity, and classification ability were satisfactory. The moderate-high correlation between PTSQ and PCL-5 ($r = 0.685$) suggested that there is a good overlap between the measures, despite some features not being shared (e.g., affectivity, sleep difficulties). These values were good but not optimal as for the IES-R, probably because the PCL-5 also measures components typical of affective disorders (e.g., sleep difficulties, mood disturbances) which are not exclusively typical of PTSD—and is one of the reasons why the PTSQ has been structured as it is.

Overall, findings of Part I suggest that the PTSQ is a self-report measure of the core symptoms of PTSS/PTSD, with high precision and well-structured items. Its clinical cutoffs are extremely useful in clinical practice to identify the individual severity level and delineate subsequent psychological interventions with the optimal level of intensity and assistance (e.g., low, medium, high).

Discussion of part II

Findings from Part II shed light on the relationships from the three trauma components to anxiety and depression symptoms, through a multiple multivariate latent regression model. As expected, the three trauma components were reciprocally associated with moderate-to-high positive and statistically significant relationships, supporting their cohesion in structuring the psychological reactions to trauma[12]. Also anxiety and depression symptoms had a strong positive and statistically significant association.

Coming to the impact of traumatic components on mental health, it emerged that: (1) the relationships from intrusion to both anxiety and depression symptoms were positive and statistically significant, and their strength was nearly the same (separation index was only 2.8%); (2) the relationship from avoidance to both anxiety and depression symptoms was not statistically significant probably because of the high correlation of avoidance and the other trauma components. Although not statistically significant, the relationship from avoidance to depression symptoms was stronger than from avoidance to anxiety symptoms (the separation index was 69.2%). However, these relationships were not statistically significant, thus their interpretation requires caution, it is purely speculative, and needs to be supported or disconfirmed by future studies despite being in line with cognitive literature pointing out avoidance as a core feature of depression; (3) the relationships from hyperarousal to both anxiety and depression symptoms were positive and statistically significant, and their strength was almost comparable (separation index was 46%).

Findings from Part II showed that not all of the three trauma components had a statistically significant association with anxiety and depression symptoms, intrusion and hyperarousal did, but avoidance did not.

This is possibly due to the fact that avoidance is both a dysfunctional reaction to trauma but also a strategy that in the short term allows to suppress various stimuli, which otherwise would be able to trigger adverse psychological symptoms of anxiety and depression[28,29]. Differently, according to scientific literature, intrusions and hyperarousal are traumatic symptoms which are only dysfunctional and solely related with discomfort and negative psychological symptoms, without any functional role or strategy nor in the short or long term[23,32].

The strength of the impact of intrusions and hyperarousal was compared relying on the separation index. When compared to intrusion, hyperarousal had a stronger impact on both anxiety (separation index = 99.4%) and depression (separation index = 95.6%) symptoms—meaning that the strength of their standardized beta was extremely different. This finding is in line with evidence from scientific literature stressing the importance of a hyperarousal-subtype of post-traumatic reactions and disorder[32]. Moreover, intrusions, despite being extremely unpleasant, are still something that can undergo the subjective appraisal and cognitive processing, thus not necessarily generating anxious and depressive symptoms[24,26]. Differently, hyperarousal entails a somatic component that has a more direct effect on anxious and depressive symptoms—with which also shares some features (e.g., being fidgety or restless).

Limitations and future research

This research is not free of limitations. First, it relied on self-report tools and there were no clinical interviews to ascertain the impact of trauma nor a formal PTSD diagnosis. However, all the assessment tools about trauma are well-validated and all provided congruent results in detecting trauma symptoms. Second, in this cross-sectional research design no causal relationships can be proved, but the reliable statistical methodologies allowed testing the hypotheses of associations and directed influences among constructs. Future research may use longitudinal designs to investigate the impact of trauma over time[61]. Third, this study considered a limited number of variables, and third confounding variables may have an effect (e.g., anxiety sensitivity, difficulties in emotion regulation, social support)[62], which could be tested by future studies. Fourth, the sample is quite unbalanced in terms of sex in favor of females, thus more research is needed to fully elucidate the complex sex-specific mechanisms. Indeed, the available evidence points to sex differences in the risk, presentation, and underlying mechanisms of PTSD, with higher prevalence in women compared to men, due to an interaction of sex differences in trauma exposure, stress response, coping, and neurobiology[63,64]. Future studies may also consider gender and ethnic differences[65]. Another limitation is in the methods used for identifying clinical cut-off points[66]. In fact, the accuracy of ROC analysis depends on the quality of the gold standard[67], and in this sense, a clinical interview and/or judgment might be much more accurate in determining which individuals have a particular condition. However, an increasing number of studies suggest that self-report methods can be considered superior to clinician-administered interview reports[68] due to the potentially higher levels of clinician influence/error in the latter. For these reasons, future studies will integrate the use of self-report gold-standard instruments with clinical judgment and/or a diagnostic interview as a reference.

Beyond the aim of this study, an important aspect of trauma research for the future involves trauma susceptibility factors[61,69]—such as genetic, biological, neuroendocrine, epigenetic influences, cognitive, and psychological[70]. Factors affecting vulnerability to PTSD include not only clear preexisting mental health conditions but also subclinical transdiagnostic elements like negative attributional styles, intolerance of uncertainty, looming cognitive styles, and emotional regulation[71–73].

Strengths

Despite these limitations, this research displays several strengths. First, the use of a large sample with individuals of different ages who had traumatic experiences. Second, the precise and sound methodology and statistical analysis relying on corroborated procedures. Fourth, the identification of cut-offs of the PTSQ, which are useful for the clinical and research practice to distinguish different severity levels of PTSS. Fifth, re-confirming the factorial structure of the PTSQ and its sound psychometric properties (also in adults above 30 years old), together with the possibility to shed light on the relationships between the three core trauma components and the symptoms of anxiety and then depression.

Implications for clinical and research practice

The implications of the present research are relevant both for the research and clinical practice. It is important to rely on accurate and reliable assessment tools for estimating the presence, severity, and prevalence of psychological issues—such as PTSS—even in clinical and research contexts. To give some examples, in research contexts may be useful to rely on a brief and sound measurement tool to estimate the comorbidities among psychological issues. In clinical practice, it is important to screen for PTSS in order to give more clinical attention to individuals with higher scores (e.g., above the cut-offs), set a clinical interview for the diagnostic process and then choose the most suitable psychological and/or psychiatric interventions.

Regarding the cut-offs', they have extreme utility for the clinical contexts. With the increasing gap between mental health needs and resources, it is important to optimize the allocation of health-professional resources towards individuals most at risk of PTSD. To do so, self-report screening questionnaires are useful and effective tools to help identify individuals reporting highest PTSS and more likely to display a PTSD[4]. Then, formulating a formal diagnosis of PTSD is a delicate process that only a clinician can perform through a clinical interview requiring dedicated time and efforts. Then, evidence-based clinical interventions for PTSD should be planned.

Furthermore, the present research discloses some fruitful practical applications of the PTSQ for the clinical practice. Measurement-based care (MBC) and evidence-based assessment (EBA) are essential for advancing the treatment of post-traumatic stress disorder (PTSD), enhancing the effectiveness of clinical interventions. MBC systematically utilizes standardized measurements and fosters collaboration between patients and clinicians, thus

improving clinical decision-making and allowing for personalized adjustments based on patient outcomes[74]. EBA involves the use of validated tools to assess PTSD symptoms and monitor treatment progress. Adherence to evidence-based psychotherapies correlates with improved patient outcomes, and stricter adherence to quality standards in psychotherapy for PTSD was associated with better symptom improvement[75]. The integration of MBC and EBA in PTSD treatment leads to more effective and tailored care; by systematically monitoring patient progress and employing validated assessment tools, clinicians can enhance treatment outcomes and ensure that interventions are responsive to individual patient needs[75].

In this framework, metanalytic evidence showed the effectiveness of psychotherapy treatments in reducing PTSD symptoms[76], including the Eye Movement Desensitization Reprocessing (EMDR) therapy[77]. EMDR has been identified among the recommended treatments by major health organizations, including the American Psychiatric Association and the World Health Organization, as a frontline treatment for PTSD[78].Research has consistently shown that EMDR is effective in reducing PTSD symptoms, often yielding rapid results. Studies indicate that many patients experience significant improvements in a relatively short timeframe, sometimes within just a few sessions. A recent systematic review showed that in all the considered studies EMDR improved the PTSD symptoms in adults inpatients[79]. Overall, EMDR therapy is recognized as a highly effective treatment for PTSD, facilitating emotional healing and cognitive restructuring through its unique approach to processing traumatic memories.[80] Scientific evidence highlighted that the mechanisms of action of EMDR rely on modifications of neuroanatomical pathways[81,82] and the re-encoding of aversive traumatic memory[83]. Its rapid efficacy and adaptability make it a valuable option for those suffering from trauma-related conditions[84], supporting the use of evidence-based treatments for PTSD in psychotherapy[85].

Conclusion

Summarizing, overall, findings from this research study support the psychometric and clinical usefulness of the PTSQ both in clinical and research studies, as it is a brief, strong and sound tool to measure the core components of the psychological impact of traumatic experiences, and it is also useful to model their relationships with other key psychological constructs, such as anxiety and depression. This study provides useful preliminary evidence about the PTSQ by anchoring its scores to other two measures of PTSD that offer a measure of the risk of the diagnosis. These findings highlight the importance of PTSS and their components in influencing the subsequent psychological issues related to mental health, underlying the key role of PTSS and thus the importance of measuring it.

In conclusion, the PTSQ is a sound and valid assessment tool suitable to measure the core post-traumatic stress symptoms, also providing clinical cut-offs to determine a higher risk of PTSD. Moreover, it is important to consider the relations from the core trauma components of hyperarousal, intrusion and avoidance with the anxious and depressive symptoms to inform clinical interventions aimed at reducing the impact of traumatic events on the mental health of individuals.

Data availability

The datasets presented in this article are not readily available because due to privacy restrictions, data were available from the corresponding author on a reasonable request.

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A.A.R.: conceptualization, formal analysis, methodology, writing the original draft, review, and editing. A.P.: data collection, writing the original draft, formal analysis, methodology, writing the original draft, review, and editing. I.F.: review and editing. R.I.: review and editing. F.T.: review and editing. S.M.: review and editing.

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