Scientia Psychiatrica
Vol. 7, No. 3, 2026, pp. 137–148 · e-ISSN 2715-9736 journal homepage: scientiapsychiatrica.com

ORIGINAL RESEARCH ARTICLE

Construct Overlap and Threat-Arousal Bridges Across Post-Traumatic Stress, Insomnia, and Anxiety in Ukrainian Adults During War: An Ordinal Network Analysis

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ARTICLE INFO

Article history
Received: May 17, 2026
Revised: June 20, 2026
Accepted: July 8, 2026
Available online: July 26, 2026
Published: July 30, 2026

Keywords
Anxiety
Bridge centrality
Insomnia
Network analysis
Post-traumatic stress
Ukraine

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DOI
10.37275/scipsy.v7i3.215

ABSTRACT

Background. Post-traumatic stress, insomnia, and anxiety often co-occur during armed conflict, but total scores cannot show which symptoms connect the domains.

Objective. To estimate an item-level symptom network in Ukrainian adults during war, identify cross-domain bridges, and test their robustness to estimation, overlap, and sample choices.

Methods. This secondary cross-sectional analysis used responses from 241 Ukrainian adults recruited online in December 2024. Predefined communities comprised seven Insomnia Severity Index (ISI), seven Generalized Anxiety Disorder-7 (GAD-7), and 20 PTSD Checklist for DSM-5 (PCL-5) items. A rank-based Gaussian-copula matrix was regularized with graphical lasso and the extended Bayesian information criterion (EBIC; $\gamma = 0.50$); bridge expected influence quantified cross-community connections. Accuracy was evaluated with 500 fixed-tuning bootstraps, case-dropping, and four sensitivity analyses.

Results. Of 561 possible edges, 223 were nonzero, 106 of them cross-scale. PCL-5 sleep difficulty had the largest bridge expected influence (1.059; 95% bootstrap interval 0.871–1.207), followed by GAD-7 fear that something awful might happen (0.682; 0.488–0.888), GAD-7 irritability (0.603), ISI sleep-onset difficulty (0.591), and PCL-5 irritability/aggression (0.566). The strongest cross-scale edges joined parallel sleep items (0.460) and irritability items (0.473). Rankings changed little under polychoric estimation, lower EBIC γ, and N = 242 (Spearman $\rho = 0.993$–1.000). Without the two overlapping PCL-5 items, concordance remained substantial ($\rho = 0.874$), and fear, startle, relaxation, concentration, restlessness, and hypervigilance became prominent.

Conclusion. Bridges reflected shared item content and a broader threat-arousal pattern. Sleep, fear, irritability, startle, relaxation, and concentration should be assessed together; cross-sectional centrality is not a causal treatment target.

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1. Introduction

Russia's full-scale invasion of Ukraine has exposed millions of people to repeated threats, displacement, bereavement, disrupted routines, economic uncertainty, and the prolonged expectation of further attacks. These stressors have no clear endpoint. They recur through daily life, shape decisions about safety and mobility, and can keep body and mind on alert long after an alarm has passed. Since the invasion, studies of Ukrainians have documented considerable post-traumatic stress, anxiety, depressive symptoms, sleep disruption, and reduced wellbeing, although estimates differ with sampling frame, exposure profile, instrument, and assessment period.[1–8] That variation matters clinically. A single prevalence figure cannot capture the heterogeneity of war-related distress, and the way symptoms are organized may say as much as their total severity.

Post-traumatic stress symptoms, insomnia, and generalized anxiety tend to cluster under sustained threat. Intrusive memories and nightmares can disrupt

sleep. Avoidance and safety behaviors can narrow daily activity, and hypervigilance can delay sleep onset; in turn, insufficient or fragmented sleep can amplify emotional reactivity and threat perception and make concentration harder. Recent work on people living in Ukraine, displaced Ukrainians, university and medical students, and refugees has linked wartime exposure with trauma-related symptoms, insomnia, allostatic burden, and impaired mental health; it has also shown that context-adapted sleep and coping interventions are feasible.[9–15] Generalized worry may prolong cognitive activation before sleep, and fatigue and weakened executive control may reduce a person's ability to regulate worry or disengage from trauma reminders. Scale totals can show that these domains travel together. They cannot show whether the link is concentrated in sleep, irritability, fear, startle, concentration, or some other symptom.

Symptom-network analysis offers another way to represent these data. Symptoms are nodes, and edges summarize conditional associations once the remaining symptoms have been taken into account. Communities can be fixed in advance by the instruments used for insomnia, anxiety, and post-traumatic stress; a bridge symptom is a node with comparatively strong links to nodes outside its own community. Empirical networks have repeatedly pointed to disturbed sleep, fear, irritability, and difficulty relaxing as connectors between trauma-related and internalizing symptom communities.[16–21] The question shifts from "Which disorders correlate?" to "Which reported experiences account for cross-domain connectivity?"

Earlier network studies give further reason to expect sleep and hyperarousal symptoms to link trauma-related and anxiety-related communities. Networks estimated in clinicians, adolescents, older adults, community samples, and trauma-exposed workers have shown insomnia, anxiety, worry, restlessness, and arousal to be conditionally intertwined and not isolated symptom sets.[22–30] Two measurement problems deserve explicit attention. First, the Posttraumatic Stress Disorder (PTSD) Checklist for the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; PCL-5) includes sleep difficulty and irritability/aggressive behavior, content that overlaps with the Insomnia Severity Index (ISI) and the Generalized Anxiety Disorder-7 (GAD-7); a strong edge between near-parallel items may reflect a genuinely shared experience. It may also inflate bridge statistics, because similar questions sit in different scale communities. Second, the items are ordinal. Treating categories as continuous and normally distributed may affect smaller edges and, through them, node rankings. Bridge centrality also has to be interpreted with restraint. A conditional association is not a temporal pathway. A node that is central in a cross-sectional group network is not automatically the best intervention target for an individual, and centrality estimates can shift with item selection, community definitions, regularization, and sample composition; a useful network analysis therefore keeps the empirical ranking apart from the causal claims the design can carry. It should show whether a bridge pattern holds up when the estimation changes in reasonable ways, and whether it persists when overlapping content is reduced.

Ukraine-specific symptom networks remain comparatively scarce, especially analyses that combine all 34 items of the ISI, GAD-7, and PCL-5 and then test directly whether the leading bridges are artifacts of overlapping questions. Pavlova and Rogowska linked war nightmares, insomnia, and post-traumatic stress among Ukrainian university students.[4] The present analysis addresses a broader adult online sample, adds generalized anxiety at item level, and evaluates bridge accuracy together with several sources of analytic uncertainty. The source survey also allows a publication-concordant sample to be reconciled with all eligible adult responses, a useful check when one complete response profile contains zeros on every analytic item. The novelty of this study is a test of whether cross-domain bridge rankings are driven by construct overlap or persist across ordinal estimation, alternative regularization, overlap reduction, and sample reconciliation, all within a single, fully itemized network; we aimed to: (1) estimate the conditional-association network among 34 post-traumatic stress, insomnia, and anxiety symptoms; (2) identify the symptoms and pairs that most strongly connected the predefined instrument communities; (3) quantify bootstrap accuracy and case-dropping stability; and (4) evaluate robustness to polychoric correlations, a less conservative EBIC setting, removal of overlapping PCL-5 sleep and irritability items, and inclusion of all eligible adults.

2. Methods

2.1. Study design and setting

Study design and data source. We performed a secondary cross-sectional analysis of de-identified responses from the Psychological Wellbeing of Ukrainian Civilians project; the source dataset and its broader descriptive report are publicly available through the Open Science Framework and have been described in a peer-reviewed data report.[1] Survey responses were collected online during December 2024. The broader questionnaire assessed sociodemographic characteristics and several dimensions of psychological wellbeing; the present study focused on the 34 items belonging to the ISI, GAD-7, and PCL-5 because the scientific question concerned bridges among insomnia, anxiety, and post-traumatic stress symptoms.

Online recruitment provided access to adults living under heterogeneous wartime conditions and to Ukrainians who were abroad at the time of assessment; it did not create a probability sample of the Ukrainian population. Accordingly, the target of inference is the association structure in the analyzed respondents, not national prevalence. Military status was not recorded as a screening variable, so we use "Ukrainian adults" rather than assuming that every participant was a civilian; the

source data included timestamps but no repeated observations; each row was treated as one respondent.

2.2. Participants

Participants and analytic sample. The downloaded workbook contained 251 responses. Age was converted to numeric form and the nine respondents younger than 18 years were excluded, leaving 242 eligible adults. All eligible respondents had complete, mappable responses on the 34 analytic items; one eligible adult selected the lowest category for every ISI, GAD-7, and PCL-5 item. The supplied analytic report used 241 adults as its publication-concordant primary sample, excluding this all-zero response profile. We retained that decision for direct reproducibility and treated inclusion of all 242 adults as a sensitivity analysis; this approach makes the reconciliation transparent without assigning a motive or validity judgment to the response pattern.

No a priori power calculation was available for this secondary network analysis; the ratio of 241 observations to 34 nodes constrains precision, particularly for small edges. We therefore used regularization, bootstrapped intervals, case-dropping stability, and sensitivity comparisons as safeguards that supplement one another. Results emphasize the magnitude and repeatability of the strongest bridges rather than claiming that every estimated edge is stable.

2.3. Variables and instruments

Measures. The Insomnia Severity Index is a seven-item self-report measure of insomnia symptoms and their perceived impact over the preceding two weeks.[31] Items assess difficulty initiating sleep, difficulty maintaining sleep, early awakening, satisfaction with the current sleep pattern, noticeability of sleep problems, worry or distress about sleep, and interference with daily functioning; each item is scored from 0 to 4, yielding a total from 0 to 28. We used conventional descriptive bands of no clinically significant insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28). In the primary sample, internal consistency was high (Cronbach's α = 0.873).

The Generalized Anxiety Disorder-7 is a seven-item measure of anxiety symptoms during the previous two weeks.[32] Items assess nervousness or feeling on edge, inability to stop or control worrying, excessive worry about different matters, difficulty relaxing, restlessness, irritability, and fear that something awful might happen. Response categories range from 0 (not at all) to 3 (nearly every day), producing a total from 0 to 21. Descriptive bands were minimal (0–4), mild (5–9), moderate (10–14), and severe (15–21). Internal consistency in the primary sample was Cronbach's α = 0.870.

The PTSD Checklist for DSM-5 is a 20-item self-report measure aligned with DSM-5 post-traumatic stress symptom criteria.[33] Items are rated from 0 (not at all) to 4 (extremely), and the total ranges from 0 to 80; the dataset used a threshold greater than 41 as a descriptive indicator of probable PTSD. This threshold was not treated as a clinical diagnosis, and trauma-criterion verification or diagnostic interviewing was not available. Internal consistency was Cronbach's α = 0.937. In item-level reporting, PCL15 denotes irritability or aggressive behavior, PCL18 denotes jumpiness or easy startle, PCL19 denotes concentration difficulty, PCL20 denotes difficulty falling or staying asleep, PCL2 denotes disturbing dreams, PCL16 denotes taking risks or doing things that could cause harm, and PCL17 denotes being "super alert" or on guard (hypervigilance).

The Ukrainian response labels were translated into their intended ordered scores with explicit dictionaries. ISI severity and impact categories were mapped to 0–4, the satisfaction item was reverse-scored, GAD-7 frequency categories were mapped to 0–3, and PCL-5 severity categories were mapped to 0–4. After mapping, ranges and total-score distributions were checked against the source report. No item-level value was imputed because the 242 eligible adults had no missing analytic responses.

2.4. Data collection procedure

Reproducibility and software. The raw workbook was preserved unchanged and checksum-verified. A reproducible script records column selection, Ukrainian response dictionaries, sample derivation, normal-score transformation, graphical-lasso estimation, descriptive statistics, and output generation. Independent reproduction confirmed sample counts, missingness, reliability coefficients, total-score correlations, primary edge count, cross-community edge count, and the central sensitivity correlations; the complete fixed-tuning bootstrap summaries were reconciled to the supplied source analysis. Numerical results were rounded only for presentation.

2.5. Statistical analysis

Descriptive and bivariate analyses. Age was summarized with mean, standard deviation (SD), median, and interquartile range (IQR); gender and descriptive severity bands were summarized with frequencies and percentages. Scale totals were reported with mean, SD, median, IQR, and observed range. Internal consistency was estimated with Cronbach's α as a descriptive property of the item sets in this sample. Associations between scale totals were quantified with Spearman rank correlations because scores were bounded and not assumed to be normally distributed. These total-score analyses contextualized the subsequent item network but were not used to select nodes or communities.

Primary network estimation. All 34 items were retained as separate nodes. The seven ISI items, seven GAD-7 items, and 20 PCL-5 items formed three communities defined before estimation. For the primary model, each item was transformed to a normal score based on its mid-rank empirical cumulative probability. Pearson correlations among transformed items therefore constituted a rank-based Gaussian-copula correlation matrix. This transformation preserves ordinal ordering, reduces sensitivity to marginal skew, and enables a

regularized partial-correlation model without assuming equally spaced raw categories.

We estimated a Gaussian graphical model with graphical lasso. The model penalizes elements of the precision matrix, shrinking smaller conditional associations to zero and reducing spurious complexity. Candidate penalties were evaluated with the extended Bayesian information criterion (EBIC), using $\gamma = 0.50$ to favor a comparatively sparse model. The selected primary penalty was $\lambda = 0.075133$. Standardized negative off-diagonal precision coefficients were reported as regularized partial correlations; a positive edge indicates that two symptoms tended to vary in the same direction after all other included symptoms were conditioned on; a negative edge indicates an inverse conditional association. Neither direction establishes temporal precedence.

Network sparsity was described as the number and proportion of nonzero edges among the 561 possible undirected pairs. We separately counted nonzero edges connecting different instrument communities. To keep numerical interpretation available even when the full 34-node graph is visually dense, the strongest cross-scale edges were tabulated with bootstrap intervals and selection proportions.

Bridge metrics. One-step bridge expected influence was the primary bridge metric. For node i, it was calculated as shown in Equation 1:

$$BEI_i = \sum_{j \notin C(i)} w_{ij} \qquad (1)$$

where the edge weight w_{ij} connects nodes i and j, and C(i) is the predefined community containing node i. Expected influence retains the sign of an edge, unlike bridge strength, which sums absolute weights. A larger positive value therefore indicates greater positive conditional connectivity to other symptom domains. Bridge strength was calculated as a supporting metric, but interpretation centered on expected influence because nearly all prominent cross-domain connections were positive.

Bridge values are comparative properties of this network, not standardized effect sizes with universal clinical thresholds; we ranked nodes and reported the ten highest bridge expected-influence estimates. We did not use centrality-derived p values or dichotomize nodes as statistically significant versus nonsignificant. The bootstrap intervals describe sampling variation in the estimated metric; they do not support confirmatory comparisons between every pair of nodes.

Accuracy and stability. Edge and bridge accuracy were evaluated using 500 nonparametric bootstrap samples drawn with replacement from the 241 primary observations; the selected primary penalty and transformation procedure were held fixed within resamples so that intervals represented case-sampling variability around the primary estimator rather than a mixture of tuning rules. Percentile intervals were calculated from the 2.5th and 97.5th bootstrap percentiles. For prominent edges, we also recorded the proportion of bootstrap networks in which an edge was nonzero.

Case-dropping stability was evaluated with 200 repetitions at removal proportions of 10%, 25%, 50%, 60%, 70%, and 75%. At each proportion, bridge expected influence from the reduced sample was correlated with the full-sample vector. The correlation-stability coefficient was defined as the largest removal proportion for which the fifth percentile of those correlations remained at least 0.70, so that 0.75 was the maximum attainable value; this threshold is stricter than merely reporting a median correlation and protects the interpretation from favorable average behavior that is not sustained across resamples.

Sensitivity analyses. Four analyses addressed distinct sources of uncertainty. First, an ordinal sensitivity used a polychoric correlation matrix followed by EBIC graphical lasso. This model directly treats observed categories as discretized manifestations of latent continuous variables. Second, the Gaussian-copula model was repeated with EBIC $\gamma = 0.25$, allowing a denser network and testing whether stronger bridge rankings depended on conservative regularization. Third, PCL15 and PCL20 were removed because their content parallels GAD6 irritability and the ISI sleep items; this overlap-reduced 32-node network tests whether the cross-domain pattern extends beyond two near-duplicate constructs. It does not "correct" the PCL-5 or claim that overlapping symptoms are unimportant; rather, it asks a narrower robustness question under a changed node set. Fourth, the primary workflow was repeated in all 242 eligible adults, including the complete all-zero profile.

Sensitivity agreement was summarized with Pearson correlation for the vector of edge weights when node sets were identical and Spearman rank correlation for bridge expected influence. For the overlap-reduced network, rank concordance used the 32 common nodes. We regarded sensitivity estimates as descriptive comparisons, not as separate hypothesis tests, and made no multiplicity adjustment because no family of confirmatory null hypotheses was tested.

2.6. Ethical approval

Ethics. Ethical approval for this secondary analysis and manuscript was granted by the CMHC Research Center Ethics Committee Indonesia (No. 2026/0230).

3. Results

3.1. Participant characteristics and symptom burden

The primary analysis included 241 adults. Mean age was 32.0 years (SD 11.0), with a median of 29 years (IQR 23–40). Participants identified as women (n = 191, 79.3%), men (n = 47, 19.5%), or another gender (n = 3, 1.2%). Participant characteristics and symptom distributions are detailed in Table 1. The table shows a mean ISI total of 10.42 (SD 6.11; median 10, IQR 6–14; range 0–28), a mean GAD-7 total of 9.08 (SD 5.02; median 8, IQR 5–13; range 0–21), and a mean PCL-5 total of 29.54 (SD 16.66; median 28, IQR 16–40; range 0–80).

Using descriptive severity bands, 85 participants (35.3%) had no clinically significant insomnia, 96 (39.8%) had subthreshold insomnia, 49 (20.3%) had moderate insomnia, and 11 (4.6%) had severe insomnia. GAD-7 severity was minimal for 52 participants (21.6%), mild for 86 (35.7%), moderate for 65 (27.0%), and severe for 38 (15.8%). Fifty-eight participants (24.1%) had a PCL-5 total greater than 41, while 183 (75.9%) were at or below that descriptive threshold. These categories characterize self-reported symptom burden and should not be read as diagnostic classifications.

The three scale totals were positively correlated. The largest association was between GAD-7 and PCL-5 (Spearman ρ = 0.806), followed by ISI and PCL-5 (ρ = 0.639), and ISI and GAD-7 (ρ = 0.602). These broad associations motivated the item-level analysis but did not identify which experiences carried the cross-domain connectivity.

Table 1. Participant characteristics and symptom burden in the primary analytic sample (N = 241).

Characteristic	Value
Age, years, mean (SD)	32.0 (11.0)
Age, median (IQR)	29 (23–40)
Women, n (%)	191 (79.3)
Men, n (%)	47 (19.5)
Another gender, n (%)	3 (1.2)
ISI total, mean (SD); median (IQR)	10.42 (6.11); 10 (6–14)
GAD-7 total, mean (SD); median (IQR)	9.08 (5.02); 8 (5–13)
PCL-5 total, mean (SD); median (IQR)	29.54 (16.66); 28 (16–40)
Internal consistency, α	ISI 0.873; GAD-7 0.870; PCL-5 0.937
PCL-5 >41, n (%)	58 (24.1)

Note. GAD-7, Generalized Anxiety Disorder-7; IQR, interquartile range; ISI, Insomnia Severity Index; PCL-5, PTSD Checklist for DSM-5; SD, standard deviation. Screening categories are descriptive and do not establish diagnosis.

3.2. Network structure

The primary network contained 223 nonzero edges among 561 possible pairs, corresponding to density 0.398. Of these, 106 connected nodes belonging to different instrument communities. The network was therefore neither fully separated by scale nor so dense that all symptoms were conditionally connected. Regularization retained a set of within- and cross-domain associations after simultaneous adjustment for the other 32 symptoms.

The strongest cross-scale edge joined GAD6 irritability with PCL15 irritability/aggressive behavior (regularized partial correlation 0.473; 95% bootstrap interval 0.364–0.559; nonzero in 100% of bootstrap networks). The next strongest joined ISI1 sleep-onset difficulty with PCL20 sleep difficulty (0.460; 0.350–0.538; 100%). PCL20 was also connected to sleep-related worry or distress (ISI6; 0.245; 0.130–0.338; 100%), and GAD4 difficulty relaxing was connected to PCL18 jumpiness/easy startle (0.233; 0.119–0.336; 100%). The ten largest cross-scale edges are detailed in Table 2. As shown in the table, all ten were positive, and nine were nonzero in at least 96.8% of bootstrap networks.

Table 2. Ten largest cross-scale edges in the primary regularized network.

Node pair	Edge	95% BI	Nonzero, %
GAD6-PCL15	0.473	0.364–0.559	100.0
ISI1-PCL20	0.460	0.350–0.538	100.0
ISI6-PCL20	0.245	0.130–0.338	100.0
GAD4-PCL18	0.233	0.119–0.336	100.0
GAD7-PCL2	0.167	0.060–0.260	99.8
GAD5-PCL17	0.148	0.020–0.233	99.0
ISI4-PCL20	0.129	0.013–0.212	98.4
ISI2-PCL20	0.122	0.000–0.208	97.0
GAD1-PCL18	0.110	0.000–0.200	96.8
ISI3-PCL16	0.106	0.000–0.191	91.8

Note. BI, fixed-tuning nonparametric bootstrap interval; GAD, GAD-7 item; ISI, Insomnia Severity Index item; PCL, PCL-5 item.

3.3. Bridge expected influence

PCL20 sleep difficulty had the largest bridge expected influence (1.059; 95% bootstrap interval 0.871–1.207). GAD7 fear that something awful might happen ranked second (0.682; 0.488–0.888), followed by GAD6 irritability (0.603; 0.489–0.790), ISI1 sleep-onset difficulty (0.591; 0.424–0.750), PCL15 irritability/aggressive behavior (0.566; 0.364–0.700), and GAD4 difficulty relaxing (0.554; 0.399–0.775). The

complete top-ten ranking and intervals are detailed in Table 3. Figure 1 visualizes the same estimates and 95% bootstrap intervals, showing that PCL18 jumpiness/easy startle, PCL19 concentration difficulty, ISI2 sleep-maintenance difficulty, and GAD1 nervousness/feeling on edge completed the leading set.

The ranking combined two types of connection. The very high positions of PCL20, ISI1, GAD6, and PCL15 were supported by strong edges between items with directly parallel content. In contrast, GAD7 fear, GAD4 difficulty relaxing, PCL18 startle, and PCL19 concentration difficulty represented conceptually related but nonidentical threat-arousal and cognitive symptoms. This distinction was examined formally in the overlap-reduced sensitivity analysis rather than resolved from wording alone.

Table 3. Ten highest one-step bridge expected-influence estimates in the primary network.

Rank	Node	Bridge EI	95% BI
1	PCL20 Sleep difficulty	1.059	0.871–1.207
2	GAD7 Fear something awful	0.682	0.488–0.888
3	GAD6 Irritability	0.603	0.489–0.790
4	ISI1 Sleep onset	0.591	0.424–0.750
5	PCL15 Irritability/aggression	0.566	0.364–0.700
6	GAD4 Trouble relaxing	0.554	0.399–0.775
7	PCL18 Jumpy/easily startled	0.545	0.381–0.739
8	PCL19 Concentration	0.472	0.237–0.611
9	ISI2 Sleep maintenance	0.469	0.294–0.659
10	GAD1 Nervous/on edge	0.445	0.270–0.648

Note. BI, fixed-tuning nonparametric bootstrap interval; EI, expected influence. Bridge EI is the signed sum of a node's edges to nodes in the other instrument communities.

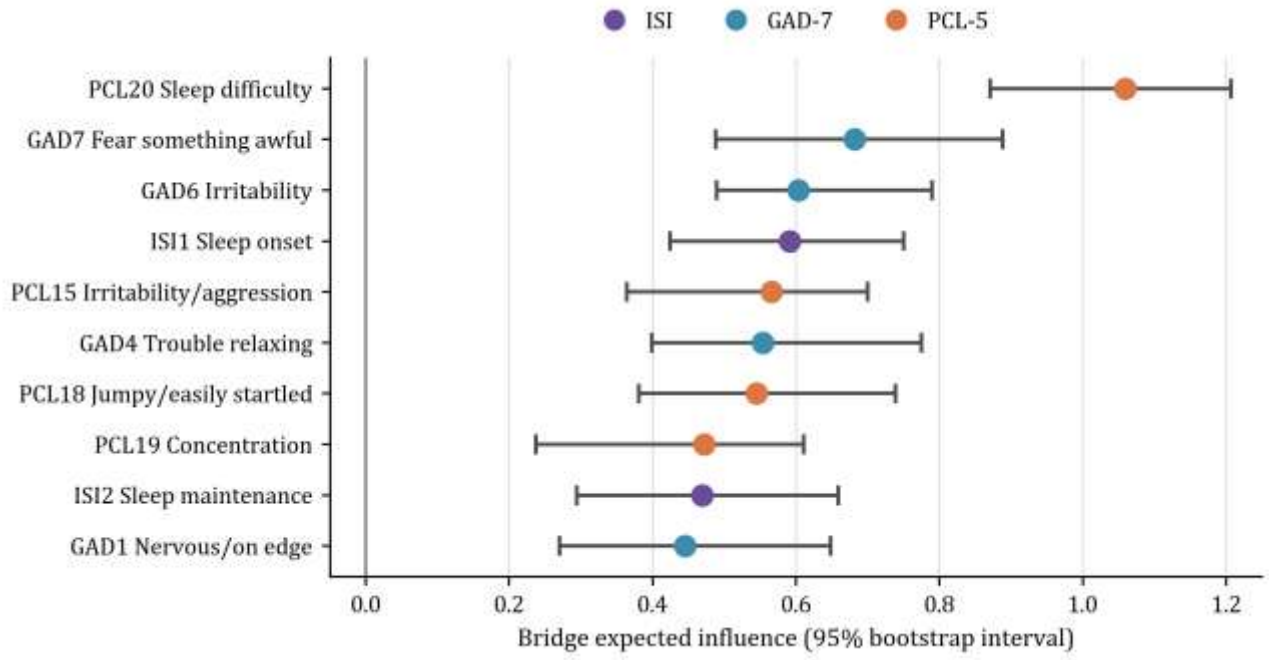


Figure 1. Ten highest bridge expected-influence estimates in the primary network. Points are estimates and whiskers are 95% fixed-tuning nonparametric bootstrap intervals. Purple denotes ISI, blue denotes GAD-7, and orange denotes PCL-5 items.

3.4. Accuracy and case-dropping stability

Bootstrap intervals for the leading bridge values remained entirely positive. The four strongest cross-scale pairs were nonzero in all 500 bootstrap networks, and five further tabulated pairs were nonzero in at least 96.8% of networks. Smaller edges outside this leading set showed greater variability, which is expected in a 34-node model with 241 observations. Interpretation therefore focuses on the magnitude and thematic coherence of the leading estimates rather than the precise presence of every small edge.

Bridge expected influence was stable under case-dropping. The correlation-stability coefficient was 0.75, the largest removal proportion tested. Even when 75% of cases were removed, the fifth percentile of the correlation between reduced-sample and full-sample bridge values was 0.709. This result supports the reproducibility of the overall bridge ordering within the analyzed sample while not eliminating uncertainty in closely ranked nodes.

3.5. Sensitivity analyses

The principal bridge ordering was almost identical when the ordinal categories were modeled with

polychoric correlations (Spearman ρ = 0.993) and when EBIC γ was reduced from 0.50 to 0.25 (ρ = 0.997). The polychoric model retained 197 edges, whereas the less conservative γ setting produced a denser model; neither change displaced the leading sleep, irritability, fear, and arousal nodes. Inclusion of all 242 eligible adults also produced virtually identical edge weights (Pearson r = 1.000 after rounding) and bridge ranks (ρ = 1.000).

Removing PCL15 and PCL20 yielded a 32-node network with 211 reported nonzero edges and substantial, though lower, bridge-rank concordance with the corresponding primary nodes (ρ = 0.874). In this model, GAD7 fear that something awful might happen ranked first (bridge expected influence 0.695), followed by PCL18 jumpiness/easy startle (0.611), GAD4 difficulty relaxing (0.572), PCL19 concentration difficulty (0.488), GAD5 restlessness (0.430), PCL17 hypervigilance (0.425), GAD1 nervousness/feeling on edge (0.414), GAD6 irritability (0.385), ISI2 sleep-maintenance difficulty (0.371), and GAD3 excessive worry (0.327). The comparative results are detailed in Table 4, and Figure 2 displays their rank concordance with the primary model. Together, these displays show that overlap reduction changed the upper ordering, as intended, but did not dissolve cross-domain connectivity: the remaining bridges converged on anticipatory threat, physiological arousal, inability to relax, sleep continuity, and cognitive control.

Table 4. Sensitivity of bridge rankings and leading overlap-reduced nodes.

Analysis	Bridge rank ρ	Edge agreement	Leading result
Polychoric EBIC graphical lasso	0.993	Not directly compared	Primary bridge pattern retained; 197 edges
EBIC γ = 0.25	0.997	High	Primary bridge pattern retained
Overlap-reduced, 32 nodes	0.874	Different node set	GAD7, PCL18, GAD4, PCL19, GAD5, PCL17
All eligible adults, N = 242	1.000	Pearson r = 1.000	Primary bridge pattern retained

Note. Rank correlations are Spearman correlations with the primary bridge expected-influence vector; overlap-reduced concordance uses the 32 common nodes. EBIC, extended Bayesian information criterion.

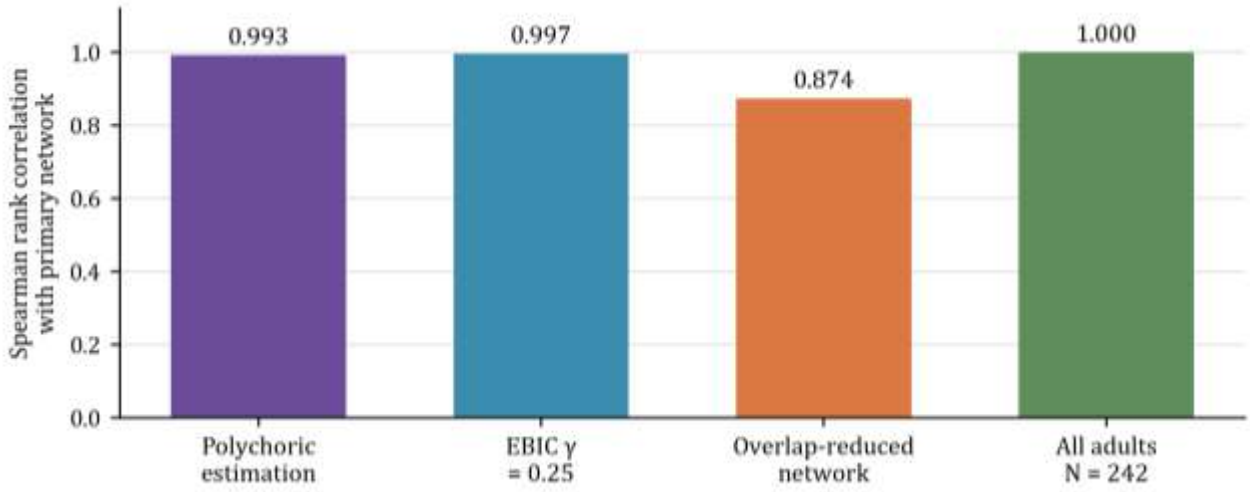


Figure 2. Concordance of bridge expected-influence rankings across sensitivity analyses. Bars show Spearman rank correlations with the primary network; the overlap-reduced correlation uses the 32 common nodes.

4. Discussion

4.1. Principal findings

This item-level analysis identified a densely connected interface among post-traumatic stress, insomnia, and anxiety symptoms in Ukrainian adults assessed during war. PCL-5 sleep difficulty was the largest bridge in the primary network. Fear that something awful might happen, anxiety-related irritability, insomnia-related sleep-onset difficulty, PTSD-related irritability/aggression, difficulty relaxing, startle, concentration difficulty, sleep-maintenance difficulty, and feeling nervous or on edge also showed prominent cross-community connectivity; the strongest individual edges paired nearly parallel sleep and irritability items. Once those two overlapping PCL-5 items were removed, the ranking moved toward fear, startle, relaxation difficulty, concentration difficulty, restlessness, hypervigilance, and sleep maintenance. Taken together, the two models say more than either alone. Construct overlap appears to have contributed materially to the highest primary bridges, yet a recognizable threat-arousal interface remained after the overlap was reduced.

The leading estimates did not depend on one correlation model, one regularization setting, or one decision about sample reconciliation. Bridge ranks were nearly identical under polychoric estimation, a lower EBIC γ, and inclusion of the all-zero adult profile. Bootstrap intervals for the leading bridges were positive, and case-dropping stability remained high. Symptom-network studies in trauma-exposed, first-responder, military, student, nursing, community, and generalized-anxiety samples have likewise reported dynamic or cross-sectional links among arousal, anxiety, sleep, and post-traumatic stress.[34–42] Insomnia-focused networks have placed anxiety, psychological symptoms, and

hyperarousal at the interface between sleep and emotion.[43–45] These comparisons support the descriptive coherence of the present pattern. They do not show which symptom started it, or whether changing one node would cause improvement downstream.

4.2. Comparison with the existing literature

Construct overlap as an empirical result. The edge between PCL20 sleep difficulty and ISI1 sleep-onset difficulty was the second strongest cross-scale association, and the edge between PCL15 irritability/aggression and GAD6 irritability was the strongest. These results should not be dismissed as measurement artifacts. When people describe the same or a closely related experience in different questionnaire contexts, the agreement carries real information: sleep disturbance and irritability belong to the diagnostic architecture of post-traumatic stress and also define insomnia and anxiety burden. Even so, placing near-parallel items in separate instrument communities mechanically gives their connection extra weight in a bridge statistic. The primary network therefore shows how the administered scales interconnect; the overlap-reduced model asks which links remain once the most direct semantic duplication is taken out.

This distinction matters for comorbidity research. Symptom scales were built to measure clinically recognizable syndromes and not to supply mutually exclusive item vocabularies. Overlap can stand for shared diagnostic criteria, transdiagnostic processes, or duplicated wording, in different proportions. Empirical networks spanning post-traumatic stress, insomnia, anxiety, grief, and somatic symptoms show that shared content can form an important part of cross-community structure.[16–18] Reporting both the primary and the overlap-reduced network avoids two unsatisfactory extremes: treating shared symptoms as though they had no measurement implications, or deleting them and thereby hiding clinically real co-occurrence. Here the reduced network kept considerable rank concordance and displayed the nonduplicate threat-arousal structure more clearly.

4.3. Interpretation and mechanism

Threat anticipation and arousal. Fear that something awful might happen ranked second among the primary bridges and first after overlap reduction. During an ongoing war, anticipatory fear is not necessarily an irrational prediction detached from the environment. Air-raid alerts, uncertainty about attacks, family separation, disrupted housing, and shifting security conditions can sustain realistic monitoring of danger; the GAD-7 item may therefore capture a mixture of generalized anxious expectancy and context-sensitive threat anticipation. Its links across communities agree with the strong total-score correlation between anxiety and post-traumatic stress, and with earlier networks in which fear and arousal symptoms connected symptom clusters.[26–30,34–42] Startle, hypervigilance, restlessness, inability to relax, and feeling on edge formed the surrounding arousal pattern; these symptoms are conceptually distinct, yet they share a difficulty in downregulating readiness. Hypervigilance involves sustained monitoring. Startle is a rapid response to sudden cues. Restlessness is behavioral or bodily activation, and difficulty relaxing reflects a failure to move into a lower-arousal state. Their prominence after the PCL sleep and irritability items were removed suggests that duplicated wording did not organize the network alone; a persistent state of threat readiness may link anxious expectation to trauma-related reactivity and may interfere with the conditions that sleep requires.

The Ukrainian evidence base supports the salience of this context, although the present sample is not nationally representative. Nationwide, convenience, student, refugee, and healthcare-worker studies have documented post-traumatic stress, anxiety, sleep disruption, and perceived threat since the invasion.[1–15] Pavlova and Rogowska reported specific links among war nightmares, insomnia, and post-traumatic stress in university students.[4] Our analysis extends that work by including generalized anxiety at item level and by showing that anticipatory fear and relaxation difficulty stay important after direct sleep and irritability overlap is reduced.

Sleep as a cross-domain interface. Sleep difficulty was the most prominent bridge in the primary model, and both sleep onset and sleep maintenance appeared among the leading nodes. Several nonexclusive mechanisms could let sleep connect domains. Trauma reminders and nightmares may fragment sleep. Hypervigilance may make disengaging from environmental monitoring feel unsafe, and worry may increase cognitive activity at bedtime. Irregular schedules or nighttime alerts may disrupt the opportunity to sleep; in the other direction, insufficient sleep can intensify negative affect, weaken attentional control, increase irritability, and lower the threshold for threat responses. Cross-sectional data cannot say which of these sequences predominates. The network does identify sleep as a shared interface that deserves direct assessment.

Earlier symptom networks have also placed sleep between post-traumatic stress and other forms of distress.[16–30] Xu and colleagues found links among prolonged grief, post-traumatic stress, and insomnia symptoms, and Astill Wright and colleagues described disturbed sleep as a connector between post-traumatic stress and somatization.[16,17] Multi-domain networks and recent insomnia-focused networks likewise show that insomnia is not separate from emotional symptom systems.[18–30,43–45] The present finding is therefore not unique to Ukraine; its wartime interpretation, however, has to include environmental sleep disruption: a sleep complaint during repeated alerts may reflect an individual's symptom process and also an adaptive response to a hazardous setting.

The overlap-reduced model refines this conclusion without overturning it. Removing PCL20 eliminated the one PTSD item that most directly duplicated insomnia

content, and ISI nodes moved down the upper ranking. Sleep-maintenance difficulty nevertheless stayed among the ten leading bridges. Sleep connectivity is therefore not entirely attributable to asking about sleep twice. The result also cautions against presenting the primary PCL20 bridge value as independent evidence of a unique mechanism.

Irritability, concentration, and functional meaning. Irritability was prominent in both the primary and the reduced model. Under sustained threat, it can reflect sleep loss, heightened arousal, frustration, reduced privacy, family strain, or repeated interruption of goals. The strong GAD6-PCL15 edge partly reflects parallel content, yet GAD6 remained a leading bridge after PCL15 was removed; that residual position supports irritability as more than a duplicate indicator. Clinically, irritability may be experienced as interpersonal tension as well as internal distress, and that tension can affect social support when support is especially protective.

Concentration difficulty also stayed prominent. Attention may be divided among ordinary tasks, trauma reminders, safety monitoring, and worry about future events, and sleep disruption further reduces sustained attention and working-memory efficiency. The cross-domain connectivity of PCL19 may therefore indicate a functional convergence point and not a disorder-specific symptom; its practical importance lies in possible effects on study, work, caregiving, adherence to safety instructions, and decision-making. A bridge estimate is not a direct measure of disability, however. Future work should test whether concentration bridges predict functional outcomes beyond total symptom severity.

The difference between statistical and clinical importance is essential. A bridge expected-influence value summarizes conditional connectivity inside the estimated network. It does not quantify how distressing a symptom is, how common it is, or how much functioning would improve if it changed; the numerical lead of PCL20 may be partly attributable to overlap, whereas a lower-ranked symptom such as concentration difficulty may have large practical consequences. Clinical prioritization should combine symptom severity, impairment, patient preference, safety, feasibility, and context, and should not rest on network rank alone.

4.4. Implications for practice and policy

Clinical and public-health implications. The findings suggest the value of integrated assessment. When a Ukrainian adult reports post-traumatic stress symptoms, brief questions about sleep initiation, sleep maintenance, anticipatory fear, irritability, startle, relaxation, and concentration may uncover cross-domain burden that a single total score hides. Likewise, insomnia presentations during prolonged conflict may call for assessment of trauma reminders and threat monitoring, and anxiety presentations may benefit from questions about nighttime disruption and environmental safety. This argues for coordinated assessment. It does not argue for assigning several diagnoses from screening questionnaires.

Intervention planning should remain sensitive to context. Standard sleep advice may be hard to follow during alerts, displacement, crowding, shift work, or unstable housing. Trauma-focused care may need to acknowledge danger that is ongoing and not historical, and relaxation practices should not imply that vigilance is simply maladaptive while external threats remain credible; a stepped approach could combine practical support for safe sleep opportunity, evidence-based insomnia strategies where feasible, anxiety-management skills, and trauma-informed care. The network suggests domains that may be assessed together. It does not indicate which component should be delivered first.

At the service level, the bridge pattern may argue against a rigid separation of sleep and mental-health pathways. Brief screening and referral systems could cover both, particularly where specialist resources are limited. Digital or primary-care interventions may help with reach, but their safety, acceptability, and effectiveness under wartime conditions need direct evaluation; the results also draw attention to functional symptoms such as concentration problems, which can affect education, employment, and daily safety even when a person does not cross a screening threshold.

Future research. Future studies should recruit larger and more diverse probability-oriented samples, record military and displacement status, and measure time-varying exposure to alerts, attacks, loss, housing instability, and sleep opportunity. Repeated assessments could separate stable between-person differences from within-person fluctuations. They could also test whether changes in fear, arousal, or sleep precede changes in other domains. Ecological momentary assessment may be especially useful, since alerts, nighttime awakenings, worry, and startle can vary over hours and not months.

Measurement work should compare networks built from standard instruments with networks that use harmonized transdiagnostic items with minimal duplicated wording. Replications should report both full-scale and overlap-reduced models, define communities in advance, and test whether bridge ranks predict later functioning or treatment response beyond baseline totals. Intervention studies could then examine specific hypotheses that the present network suggests but does not answer: for example, whether improving sleep continuity reduces next-day irritability and concentration problems, or whether reducing threat-related cognitive activation improves sleep onset.

4.5. Strengths and limitations

Methodological implications. Several analytic choices strengthened inference. Communities were predefined by instrument and not discovered after the network had been seen. A rank-based Gaussian-copula model respected ordering without requiring equal category spacing, and a polychoric model gave an explicitly ordinal comparison. Conservative and less conservative

EBIC settings produced almost identical bridge ranks. Fixed-tuning bootstrap intervals separated case-sampling variability from re-selection of the penalty, and the case-dropping analysis quantified the stability of the whole bridge vector. Above all, overlap reduction tested a known interpretive vulnerability directly.

These strengths do not make centrality causal. Cross-sectional and longitudinal networks answer different questions, and the ordering of symptoms at one assessment point does not by itself identify an intervention target. Dynamic and longitudinal trauma studies show the additional temporal information needed to tell contemporaneous association from prospective influence.[34–36] The current network should be read as a conditional covariance structure at a single time point. Temporal networks would require longitudinal data, and testing whether changing a putative bridge alters other domains would require randomized or quasi-experimental studies.

The comparison of the 34-node and 32-node networks also shows why item-set sensitivity should become routine in comorbidity networks; a high centrality estimate can reflect real breadth, semantic duplication, community size, or a mixture of these. Reporting only the primary ranking would have overemphasized PCL20 and hidden how threat and arousal emerge once overlap is reduced. Reporting only the reduced ranking would have concealed how the administered clinical instruments share content. Reading the two side by side is more transparent and more faithful to the clinical picture.

Strengths and limitations. The study has several strengths. It analyzes complete item-level data from adults assessed during an active, prolonged conflict, models three clinically relevant domains at once, and keeps all standard items in the primary analysis. It uses regularization and bootstrap evaluation, and it puts the bridge ranking through four separate sensitivity analyses; the exact sample reconciliation is reported, and all eligible adults enter a dedicated sensitivity model. The analysis also keeps numerical bridge prominence apart from causal and clinical claims.

The limitations define the boundaries of interpretation. First, the cross-sectional design cannot establish temporal ordering, feedback, or causal effects, and edges are group-level conditional associations that may not describe within-person processes. Second, online convenience recruitment may overrepresent people with internet access, interest in psychological surveys, higher education, or particular exposure experiences; the sample was predominantly female, and national representativeness cannot be assumed. Third, military status, detailed conflict exposure, displacement trajectory, treatment, medication, physical health, and current safety conditions were not part of this network, and each could influence symptom structure.

Fourth, all symptoms were self-reported. Screening totals are not a substitute for diagnosis, and the PCL-5 interpretation is limited because this secondary analysis had no structured clinical interview and no explicit verification of DSM-5 Criterion A. Fifth, defining communities by instrument is transparent but partly conflates constructs with questionnaire boundaries. The overlap-reduced model handles two obvious examples. It cannot remove all semantic proximity among worry, hypervigilance, feeling on edge, startle, and inability to relax. Sixth, bridge stability was high, yet 241 observations for 34 nodes limit precision for small edges. The regularization method also introduces shrinkage bias, so numerical weights should be compared cautiously across models.

Seventh, the polychoric sensitivity analysis rests on latent-continuous assumptions, and the Gaussian-copula approach rests on a rank transformation; neither is assumption-free; their close rank agreement is reassuring but does not prove that one network is uniquely correct. Eighth, the bootstrap intervals were descriptive and fixed-tuning. They do not account for every analytic decision and do not support exhaustive pairwise claims. Finally, the war context keeps changing. Data collected in December 2024 reflect one period of the conflict, and network organization may change with exposure intensity, displacement, season, infrastructure disruption, and adaptation.

5. Conclusion

Post-traumatic stress, insomnia, and anxiety symptoms formed an interconnected conditional-association network in Ukrainian adults assessed during war. Sleep difficulty and irritability dominated the primary bridge ranking, partly because parallel content appeared in more than one instrument; once those overlapping PTSD items were removed, anticipatory fear, startle, difficulty relaxing, concentration problems, restlessness, hypervigilance, and sleep maintenance stayed prominent. The pattern held across ordinal estimation, regularization, and sample reconciliation. It supports a descriptive threat-arousal interface and not a single questionnaire artifact. Sleep, fear, arousal, irritability, and cognition should be assessed together, with attention to context. Causal prioritization must wait for longitudinal and intervention evidence.

Declarations

Use of Generative Artificial Intelligence. None.

Author Contributions. B.J.: conceptualization, methodology, software, formal analysis, data curation, visualization, writing – original draft. R.W.F.: validation, investigation, writing – review & editing. S.S.: supervision, project administration, writing – review & editing. A.M.: resources, validation, writing – review & editing.

Funding. This research received no external funding.

Conflict of Interest. The authors declare that they have no competing interests.

Ethical Approval. Ethical approval for this secondary analysis and manuscript was granted by the CMHC Research Center Ethics Committee Indonesia (No. 2026/0230).

Informed Consent. Participants in the source study provided written informed consent. The source study

reported that formal ethical review was not required under the applicable local framework. This secondary analysis used de-identified data.

Data Availability. The de-identified source dataset is publicly available from the Psychological Wellbeing of Ukrainian Civilians project on the Open Science Framework (https://osf.io/smhnr/).

Acknowledgements. None.

References

1. Kurapov A, Balashevych O, Borodko Y, et al. Psychological wellbeing of Ukrainian civilians: a data report on the impact of traumatic events on mental health. Front Psychol. 2025;16:1553555. doi:10.3389/fpsyg.2025.1553555
2. Lushchak O, Velykodna M, Bolman S, et al. Prevalence of stress, anxiety, and symptoms of post-traumatic stress disorder among Ukrainians after the first year of Russian invasion: a nationwide cross-sectional study. Lancet Reg Health Eur. 2024;36:100773. doi:10.1016/j.lanepe.2023.100773
3. Ben-Ezra M, Goodwin R, Leshem E, et al. PTSD symptoms among civilians being displaced inside and outside the Ukraine during the 2022 Russian invasion. Psychiatry Res. 2023;320:115011. doi:10.1016/j.psychres.2022.115011
4. Pavlova I, Rogowska AM. Exposure to war, war nightmares, insomnia, and war-related posttraumatic stress disorder: a network analysis among university students during the war in Ukraine. J Affect Disord. 2023;342:148-56. doi:10.1016/j.jad.2023.09.003
5. Khan AR, Altalbe A. Potential impacts of Russo-Ukraine conflict and its psychological consequences among Ukrainian adults: the post-COVID-19 era. Front Public Health. 2023;11:1280423. doi:10.3389/fpubh.2023.1280423
6. Palace M, Zamazii O, Terbeck S, et al. Mapping the factors behind ongoing war stress in Ukraine-based young civilian adults. Appl Psychol Health Well Being. 2024;16(3):868-85. doi:10.1111/aphw.12493
7. Rzońca P, Podgórski M, Łazarewicz M, et al. The prevalence and determinants of PTSD, anxiety, and depression in Ukrainian civilian physicians and paramedics in wartime: an observational cross-sectional study six months after outbreak. Psychiatry Res. 2024;334:115836. doi:10.1016/j.psychres.2024.115836
8. Xu W, Pavlova I, Chen X, et al. Mental health symptoms and coping strategies among Ukrainians during the Russia-Ukraine war in March 2022. Int J Soc Psychiatry. 2023;69(4):957-66. doi:10.1177/00207640221143919
9. Yasenok V, Baumer AM, Petrashenko V, et al. Mental health burden of persons living in Ukraine and Ukrainians displaced to Switzerland: the Mental Health Assessment of the Ukrainian Population studies. BMJ Glob Health. 2025;10(8):e019557. doi:10.1136/bmjgh-2025-019557
10. Polyvianaia M, Yachnik Y, Fegert JM, et al. Mental health of university students twenty months after the beginning of the full-scale Russian-Ukrainian war. BMC Psychiatry. 2025;25(1):236. doi:10.1186/s12888-025-06654-1
11. Karasevska T, Fiialkovska O, Mostbauer H, et al. Medical students' mental health after the first year of war in Ukraine: a cross-sectional study. J Health Psychol. 2025;30(12):3222-37. doi:10.1177/13591053251328916
12. Kurapov A, Blechert J, Hinterberger A, et al. Non-guided, mobile, CBT-I-based sleep intervention in war-torn Ukraine: a feasibility study. PLoS One. 2025;20(5):e0310070. doi:10.1371/journal.pone.0310070
13. Maciaszek J, Alejnikowa J, Dybek A, et al. Lower levels of positive affect and insomnia are associated with elevated allostatic load among Ukrainian refugees. Psychoneuroendocrinology. 2025;175:107387. doi:10.1016/j.psyneuen.2025.107387
14. Lotzin A, Morozova-Larina O, Paetow A, et al. Resilient coping during the Russian-Ukrainian war: does it buffer the effects of cumulative trauma on ICD-11 posttraumatic stress disorder symptoms? Compr Psychiatry. 2025;140:152592. doi:10.1016/j.comppsych.2025.152592
15. Karstoft KI, Bjørndal LD, Pedersen AA, et al. Associations of war exposures, post-migration living difficulties and social support with (complex) PTSD: a cohort study of Ukrainian refugees resettled in Denmark. Soc Sci Med. 2025;376:118080. doi:10.1016/j.socscimed.2025.118080
16. Astill Wright L, Roberts NP, Barawi K, et al. Disturbed sleep connects symptoms of posttraumatic stress disorder and somatization: a network analysis approach. J Trauma Stress. 2021;34(2):375-83. doi:10.1002/jts.22619
17. Xu X, Xie T, Zhou N, et al. Network analysis of prolonged grief disorder, posttraumatic stress disorder and insomnia symptoms in Chinese shidu parents with prolonged grief disorder. Eur J Psychotraumatol. 2022;13(1):2057674. doi:10.1080/20008198.2022.2057674
18. Li W, Zhao N, Yan X, et al. Network analysis of depression, anxiety, posttraumatic stress symptoms, insomnia, pain, and fatigue in clinically stable older patients with psychiatric disorders during the COVID-19 outbreak. J Geriatr Psychiatry Neurol. 2022;35(2):196-205. doi:10.1177/08919887221078559
19. Bard HA, O'Driscoll C, Miller CB, et al. Insomnia, depression, and anxiety symptoms interact and individually impact functioning: a network and relative importance analysis in the context of insomnia. Sleep Med. 2023;101:505-14. doi:10.1016/j.sleep.2022.12.005
20. Guo W, Zhao Y, Chen H, et al. The bridge symptoms of childhood trauma, sleep disorder and depressive symptoms: a network analysis. Child Adolesc Psychiatry Ment Health. 2023;17(1):88. doi:10.1186/s13034-023-00635-6
21. Tao Y, Hou W, Niu H, et al. Centrality and bridge symptoms of anxiety, depression, and sleep disturbance among college students during the COVID-19 pandemic: a network analysis. Curr Psychol. 2024;43(15):13897-908. doi:10.1007/s12144-022-03443-x
22. Peng P, Liang M, Wang Q, et al. Night shifts, insomnia, anxiety, and depression among Chinese nurses during the COVID-19 pandemic remission period: a network approach. Front Public Health. 2022;10:1040298. doi:10.3389/fpubh.2022.1040298
23. Wang S, Hou W, Tao Y, et al. Mapping network connection among symptoms of anxiety, depression, and sleep disturbance in Chinese high school students. Front Public Health. 2022;10:1015166. doi:10.3389/fpubh.2022.1015166
24. Bai W, Zhao YJ, Cai H, et al. Network analysis of depression, anxiety, insomnia and quality of life among Macau residents during the COVID-19 pandemic. J Affect Disord. 2022;311:181-8. doi:10.1016/j.jad.2022.05.061
25. Cai H, Zhao YJ, Xing X, et al. Network analysis of comorbid anxiety and insomnia among clinicians with depressive symptoms during the late stage of the COVID-19 pandemic: a cross-sectional study. Nat Sci Sleep. 2022;14:1351-62. doi:10.2147/NSS.S367974
26. Zhang L, Tao Y, Hou W, et al. Seeking bridge symptoms of anxiety, depression, and sleep disturbance among the elderly during the lockdown of the COVID-19 pandemic:

a network approach. Front Psychiatry. 2022;13:919251. doi:10.3389/fpsyt.2022.919251

27. Cha EJ, Jeon HJ, Chung S, et al. Central symptoms of insomnia in relation to depression and COVID-19 anxiety in the general population: a network analysis. J Clin Med. 2022;11(12):3416. doi:10.3390/jcm11123416
28. Wang S, Sit HF, Garabiles MR, et al. A network analysis investigation of the comorbidity between sleep dysfunction and PTSD symptomatology among Filipino domestic workers in Macao, China. J Psychiatr Res. 2021;140:337-45. doi:10.1016/j.jpsychires.2021.05.040
29. Wang N, Wang M, Xin X, et al. Exploring the relationship between anxiety, depression, and sleep disturbance among HIV patients in China from a network perspective. Front Psychiatry. 2021;12:764246. doi:10.3389/fpsyt.2021.764246
30. Ralph-Nearman C, Williams BM, Ortiz AML, et al. Pinpointing core and pathway symptoms among sleep disturbance, anxiety, worry, and eating disorder symptoms in anorexia nervosa and atypical anorexia nervosa. J Affect Disord. 2021;294:24-32. doi:10.1016/j.jad.2021.06.061
31. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med. 2001;2(4):297-307. doi:10.1016/S1389-9457(00)00065-4
32. Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006;166(10):1092-7. doi:10.1001/archinte.166.10.1092
33. Blevins CA, Weathers FW, Davis MT, et al. The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): development and initial psychometric evaluation. J Trauma Stress. 2015;28(6):489-98. doi:10.1002/jts.22059
34. Stefanovic M, Takano K, Wittekind CE, et al. Dynamic symptom associations in posttraumatic stress disorder: a network approach. Eur J Psychotraumatol. 2024;15(1):2317675. doi:10.1080/20008066.2024.2317675
35. Baker LD, Ponder WN, Carbajal J, et al. Mapping PTSD, depression, and anxiety: a network analysis of co-occurring symptoms in treatment-seeking first responders. J Psychiatr Res. 2023;168:176-83. doi:10.1016/j.jpsychires.2023.10.038
36. Crowe ML, Harper KL, Moshier SJ, et al. Longitudinal PTSD network structure: measuring PTSD symptom networks over 5 years. Psychol Med. 2023;53(8):3525-32. doi:10.1017/S0033291722000095
37. Su Y, Li M, Meng X, et al. Symptom patterns in the co-occurrence of depressive and generalized anxiety symptoms: a network analysis of a Canadian nationally representative sample. J Affect Disord. 2024;351:888-94. doi:10.1016/j.jad.2024.01.266
38. Peng J, Yuan S, Wei Z, et al. Temporal network of experience sampling methodology identifies sleep disturbance as a central symptom in generalized anxiety disorder. BMC Psychiatry. 2024;24(1):241. doi:10.1186/s12888-024-05698-z
39. Liu J, Gui Z, Chen P, et al. A network analysis of the interrelationships between depression, anxiety, insomnia and quality of life among fire service recruits. Front Public Health. 2024;12:1348870. doi:10.3389/fpubh.2024.1348870
40. Li J, Luo C, Liu L, et al. Depression, anxiety, and insomnia symptoms among Chinese college students: a network analysis across pandemic stages. J Affect Disord. 2024;356:54-63. doi:10.1016/j.jad.2024.04.023
41. Wei H, Liu M, Wang Z, et al. Anxiety, depression, and post-traumatic stress disorder in nurses exposed to horizontal violence: a network analysis. BMC Nurs. 2024;23(1):750. doi:10.1186/s12912-024-02408-8
42. Jeon ME, Rogers ML, Udupa N, et al. Suicidal ideation and attempts and hyperarousal in military personnel and veterans: network analysis reveals roles of anxiety sensitivity and insomnia. Psychol Trauma. 2025;17(4):786-94. doi:10.1037/tra0001685
43. Liu Y, Luo S, Jiang C, et al. The bridge between anxiety and insomnia symptoms among Chinese adults before and after SARS-CoV-2 vaccination: a network analysis. Front Psychiatry. 2025;16:1604309. doi:10.3389/fpsyt.2025.1604309
44. Carpi M, Marques DR, Liguori C, et al. Unraveling the insomnia web: a network analysis of insomnia and psychological symptoms in good and poor sleepers among young adults. Sleep Med. 2025;132:106590. doi:10.1016/j.sleep.2025.106590
45. Jiménez-Gonzalo L, García-Batalloso I, Márquez-González M, et al. The role of hyperarousal for understanding the associations between sleep problems and emotional symptoms in family caregivers of people with dementia: a network analysis approach. J Sleep Res. 2025;34(1):e14310. doi:10.1111/jsr.14310