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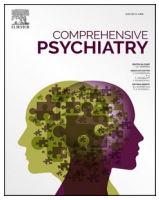

Relationships between trauma types and psychotic symptoms: A network analysis of patients with psychotic disorders in a large, multi-country study in East Africa

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ABSTRACT

Background: The link between trauma exposure and psychotic disorders is well-established. Further, specific types of trauma may be associated with specific psychotic symptoms. Network analysis is an approach that can advance our understanding of the associations across trauma types and psychotic symptoms.

Methods: We conducted a network analysis with data from 16,628 adult participants (mean age [standard deviation] = 36.3 years [11.5]; 55.8% males) with psychotic disorders in East Africa recruited between 2018 and 2023. We used the Life Events Checklist and the Mini International Neuropsychiatric Interview to determine whether specific trauma types experienced over the life course and specific psychotic symptoms were connected. We used an Ising model to estimate the network connections and bridge centrality statistics to identify nodes that may influence trauma types and psychotic symptoms.

Results: The trauma type "exposure to a war zone" had the highest bridge strength, betweenness, and closeness. The psychotic symptom "odd or unusual beliefs" had the second highest bridge strength. Exposure to a war zone was directly connected to visual hallucinations, odd or unusual beliefs, passivity phenomena, and disorganized speech. Odd or unusual beliefs were directly connected to transportation accidents, physical assault, war, and witnessing sudden accidental death.

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Conclusion: Specific trauma types and psychotic symptoms may interact bidirectionally. Screening for psychotic symptoms in patients with war-related trauma and evaluating lifetime trauma in patients with odd or unusual beliefs in clinical care may be considered points of intervention to limit stimulating additional psychotic symptoms and trauma exposure. This work reaffirms the importance of trauma-informed care for patients with psychotic disorders.

1. Introduction

There is a well-established link between trauma exposure and psychotic disorders [12,18,50]. Many studies have found that trauma exposure is a risk factor for developing a psychotic disorder, such as schizophrenia and bipolar disorder [33,55,58,61]. In addition, people with psychotic disorders are more likely to have past exposure to traumatic events than those without such disorders [16,39,41] and to have a relapse of their psychotic symptoms after additional stressful life events [40].

Trauma exposure defined as exposure to actual or threatened death, serious injury, or sexual violence [2], is heterogeneous and consists of many different types, such as natural disasters, physical assault, and sexual assault. Similarly, psychotic disorders are heterogeneous; they consist of a range of disorders, including schizophrenia, bipolar disorder, and schizoaffective disorder, and are characterized by the presence of diverse combinations of delusions, hallucinations, disorganized speech, and disorganized behaviors [2].

Some studies have identified direct associations between exposure to specific trauma types and specific psychotic symptoms [6,7,49], and also indirect associations through general psychopathology [22,29], suggesting that there could be different underlying mechanisms and multiple pathways between trauma experience and psychotic disorders. Early evidence has linked childhood sexual abuse and auditory hallucinations, childhood neglect, and chronic victimization such as bullying with paranoid symptoms [6,7], and suffering violence at work and strange experiences [22]. Some types of traumatic experiences, specifically rape and combat exposure, have been linked to higher endorsement of delusional experiences [49].

Network theory is an approach that has been applied to psychopathology over the last 15 years to conceptualize how mental disorders arise [8,9]. Network theory posits that symptoms may independently affect each other and can activate other symptoms in a network; thus, they are self-reinforcing symptom cycles that can exist in the absence of an underlying disorder [8,10,42]. For example, in psychotic disorders, symptoms such as delusions might trigger hallucinations that in turn, exacerbate further delusional beliefs. This can be extended to traumatic experiences, where experiencing one trauma might increase the risk of additional trauma exposure. For instance, if a person is sexually assaulted, they may experience trauma response symptoms such as anger and irritability; these might then trigger a person to act impulsively and get into fights or be physically assaulted, thus increasing a person's risk of trauma exposure. In addition, network theory posits that conditions from outside the network can trigger symptoms in a network, such as adverse life events triggering a network of symptoms [8]. By extension, experiencing a traumatic event, such as being exposed to a toxic substance, in theory, could trigger olfactory hallucinations in someone with a psychotic disorder.

It is widely accepted that trauma exposure and psychotic disorders are connected, but the link between specific trauma *types* and psychotic *symptoms* is still in its infancy. The majority of research in this area has focused on childhood trauma and in European samples. Less is known about the broader range of trauma types that can occur throughout the life course, in addition to in childhood, and in less-represented populations, such as in Africa. This exploratory and hypothesis-generating analysis examined whether specific trauma exposures at any point in one's life are associated with specific symptoms of psychosis. Using a comparably novel statistical technique in the field of psychology, network analysis, we assessed how psychotic symptoms and trauma types interact with each other in a large, multi-country sample of 16,628 adults with psychotic disorders in Ethiopia, Kenya, and Uganda.

2. Methods

2.1. Participants

Data for this analysis were collected as part of NeuroGAP-Psychosis, a case-control study examining the genetic and environmental underpinnings of psychotic disorders in Sub-Saharan Africa [53]. This paper only used data collected from cases with a psychotic disorder (no controls) in Ethiopia, Kenya, and Uganda from February 2018 to the culmination of data collection in March 2023. Cases were adults aged 18 years or older with a diagnosis of a psychotic disorder, which was operationalized as having one of the following conditions: schizophrenia; schizoaffective disorder; bipolar disorder, mania not otherwise specified; or psychotic disorder not otherwise specified. The rationale for grouping the above disorders under the umbrella of "psychotic disorders" was due to their large genetic overlap and because of diagnostic instability between the diagnoses [13,36,60]. Participants were recruited from more than 15 hospitals and community health centers in both rural and urban settings and were either inpatients at psychiatric hospitals (Ethiopia only) or outpatients at health facilities for mental health services. Cases were excluded if they had severe and intrusive levels of psychiatric symptoms at the time of consent. In addition to age and a diagnosis of a psychotic disorder, enrollment criteria for all participants required that decision-making capacity to consent [31] and be fluent in one of the languages in which the study was conducted: Acholi-Luo, Afan Oromo, Amharic, English, Kiswahili, Luganda, Lugbara, or Runyankole. Potential participants were excluded if they were under the acute influence of alcohol or drugs or were inpatients for a substance use disorder.

2.2. Procedures

Research personnel was comprised of psychiatrists, medical doctors, nurses, and bachelor-level accredited research assistants. Study staff underwent thorough training in administering the survey measures, which included item-by-item question descriptions, role-playing, and shadowing team members, and in research ethics prior to the launch of the study. Interviewers received further on-site supervision, support, and refresher trainings. All study measures were administered in person and read out loud to participants. All participants provided written informed consent or a fingerprint in lieu of a signature in case of illiteracy. After participants consented to be in the study, research staff administered the measures included in this analysis, which took approximately 15 minutes to conduct within the total NeuroGAP-Psychosis study visit. The authors of this manuscript have asserted that all procedures contributing to this work complied with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by all institutions involved in the research including the Harvard Longwood Campus Institutional Review Board (protocol #IRB17–0822). A more detailed description of NeuroGAP-Psychosis can be found in the published research protocol [53].

The study sample consisted of 16,915 cases. Two hundred and

eighty-seven participants (1.7%) were missing data from at least one item from the trauma and psychosis measures in this study. Those with missing data did not significantly differ from the rest of the sample on age, marital status, education level, or living arrangement (p = 0.06–0.95). For sex, there was a higher proportion of male participants in the missing group compared to those with complete data (63.1% vs. 55.8%, $p = 0.01$). Due to the extremely low level of missingness and the overall comparable characteristics across the samples with and without missing data, we restricted this to complete case analysis required by the Ising model. The final analytic sample was 16,628 participants.

2.3. Measures

2.3.1. Sociodemographic and clinical characteristics

For sociodemographic information, we asked participants their age, sex at birth, marital status, highest level of education achieved, and living arrangements. We also collected the primary psychiatric diagnosis for the participant.

2.3.2. Psychotic symptoms

We assessed psychotic symptoms using the Mini International Neuropsychiatric Interview (MINI) 7.0.2 standard version [51]. The MINI is a structured interview that aligns with psychiatric disorders in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) [2] and *International Statistical Classification of Diseases and Health Related Problems* (ICD-10) [62] and has been used extensively throughout Africa, including in the NeuroGAP-Psychosis study, where it had good construct validity [30,34]. Current and past positive and negative symptoms of psychosis were assessed using the 10 questions from Module K in the MINI. The first seven self-reported items capture different types of symptoms that people with psychotic disorders may have experienced in their lifetime (e.g., people spying on you or hearing things other people couldn't hear). The last three items assess observable psychotic symptoms that are captured by a rater through direct observation or chart review: disorganized or incoherent speech, disorganized or catatonic behavior, and negative symptoms. Similar to a cross-validation mapping study of the MINI K Module [14], we classified the items by corresponding psychopathological terms. For the directly observed items that assess current and past events, we derived a variable that reflected whether the event had ever occurred in a participant's life. All items were dichotomized into “yes” or “no” responses.

2.3.3. Potentially traumatic events

The Life Events Checklist for DSM-5 (LEC) is an index used to assess events that may be traumatic and can result in posttraumatic stress disorder [59]. The LEC consists of 16 different trauma types (e.g., physical assault, sexual assault), plus an additional open-ended question for “any other very stressful event or experience.” The response options for 14 exposures that can happen to a person were: “happened to me,” and “doesn't apply” (yes/no). For two items that cannot be directly experienced, “sudden violent death” and “sudden accidental death” the response options were “witnessed it” or “doesn't apply” (yes/no).

The LEC has been used extensively in Africa [26,27,52,54] and has been found to have good psychometric properties in the same study sample described here in Ethiopia, Kenya, and Uganda [25,35,43].

For the network analysis, we excluded two LEC trauma types items a priori: severe human suffering and “any other stressful event or experience.” Past research has found severe human suffering is a poorly understood item and has suggested edits to this item for clarity [48,54]. We excluded the open-ended question because it was impossible to separate out the types of traumas respondents reported for this item. We ran the network analysis two ways: one with exposure to a toxic substance and the other without. The toxic substance node did not connect to the network, which made our bridge closeness zero, therefore not allowing us to use this centrality index. (The network visualization which includes toxic substance is presented in Supplemental Fig. 1.) We then ran our final analysis without toxic substance, which gave us the ability to interpret all centrality indices. The paper going forward does not include toxic substance.

2.4. Statistical analysis

2.4.1. Descriptive statistics

We calculated descriptive statistics of the sample for age (mean and standard deviation) and counts and percentages for sociodemographic and severe mental health condition diagnosis and for item-level endorsements of the trauma types and psychotic symptoms using Stata 18 (StataCorp 2023).

2.4.2. Network estimation

Because all of our data were binary, we estimated the network structure and assessed associations between variables in the network using an Ising model [57] with the R package, *bootnet* (http://cran.r-project.org/package=bootnet) [21]. This package allows each variable to be regressed on all others. We set our model to the strictest possible parameters by requiring both coefficients to be non-zero to create an edge between two nodes. We used *eLasso* to apply a penalty and shrink weaker connections (smaller partial correlation coefficients) to zero [57]. *eLasso* thus prunes the network for spurious connections, leaving the most important connectivity structures and a sparser network that is easier to interpret analytically and visually; it also provides good specificity (low false positives), and its sensitivity (true positives) increases with sample size. In *eLasso*, we used the default gamma hyperparameter setting of 0.25 on a scale from 0 to 1, as per standard in the field for Ising models [11].

2.4.3. Network visualization

We used the R package *qgraph* (http://cran.r-project.org/package=qgraph)[20] to visualize the undirected network. Each variable in the network was represented as a node (circle), and each partial correlation between the nodes was represented as an edge (the lines between the nodes). We depicted the trauma types as blue nodes and psychotic symptoms as orange nodes. Positive partial correlations were depicted with blue edges and negative partial correlations with red edges.

2.4.4. Bridge centrality

We used the R package *networktools* to calculate the bridge centrality statistics and to identify bridge nodes between two pre-specified communities in the larger network (https://cran.r-project.org/package=networktools) [32], which we specified as trauma types (14 nodes) and psychotic symptoms (10 nodes).

We used three indices to assess bridge centrality: bridge strength, bridge betweenness, and bridge closeness. Traditional network analyses calculate centrality statistics across a whole network, whereas bridge centrality statistics measure associations between predefined different groups of nodes (“communities”) [32], in this case, between the group of trauma types and the group of psychotic symptoms.

Bridge strength is the sum of the absolute value of all edges between one node and all other nodes outside of its community, which captures which node is most connected to the nodes in a different community. For example, the sum of the absolute value from one trauma-type node to all the nodes in the psychotic symptom community. In the network visualization, we highlighted the two nodes with the highest bridge strength with a thick border.

Bridge betweenness tallies the number of times one node lies on the shortest path between two nodes from different communities and captures how important a node is in the flow of information across the communities. For example, when a trauma-type node is on the shortest path between two psychotic symptom nodes.

Bridge closeness is the inverse of the average distance between a node and all other nodes in a different community, in which a shorter distance reflects a larger effect on the network. For example, when a

trauma-type node is on the shortest path to nodes in the psychotic symptom community.

2.4.5. Network accuracy and stability

We examined the accuracy and stability of the network with 1000 bootstrapped samples using *bootnet*. We used non-parametric bootstrapping to calculate 95% bootstrapped confidence intervals around the edge weights to evaluate their accuracy and stability. We then used the case-dropping subset bootstrap to assess the stability of the bridge centrality indices. We calculated the central stability coefficient (CS-coefficient) to measure the maximum proportion of cases that can be dropped from the analyses while maintaining a 95% probability that the correlation between the original centrality indices and centrality indices of the subset versions is 0.7 or higher [21].

For the edge difference test and bridge strength difference test, we followed current reporting standards [11].

3. Results

A total of 16,628 participants were included in the present analysis (mean age = 36.3 years, SD = 11.5 years). More than half of the participants were male (55.8%), and most participants had a diagnosis of schizophrenia or psychotic disorder not otherwise specified (60.1%). (For selected demographics, see Table 1.) Persecutory delusions was the most endorsed item (76.9%), followed by auditory hallucinations (75.4%), and odd or unusual beliefs (75.0%). Physical assault was the most endorsed trauma type (29.1%), followed by witnessed sudden violent death (12.3%), and assault with a weapon (10.9%). See Table 2 for item-level endorsements, the complete wording of the items, and their mapping to the diagnostic criteria.

Table 1
Demographic and clinical characteristics of the study sample, n = 16,628.

Selected variables		Count	%
Sex at birth			
	Female	7348	*44.2*
	Male	9280	*55.8*
Primary diagnosis			
	Bipolar Disorder & Mania NOS	6296	*37.9*
	Schizophrenia & Psychosis NOS	9991	*60.1*
	Schizoaffective Disorder	341	*2.1*
Age categories (years)			
	18–29	5246	*31.6*
	30–44	7586	*45.6*
	45–59	3124	*18.8*
	60+	672	*4.0*
Marital status			
	Single	7779	*46.8*
	Married or cohabitating	5438	*32.7*
	Widowed	596	*3.6*
	Divorced or separated	2808	*16.9*
Level of education achieved			
	No formal education	608	*3.7*
	Primary	5929	*35.7*
	Secondary	6335	*38.1*
	University	3754	*22.6*
Living arrangements			
	Alone	1745	*10.5*
	With parents	6626	*39.9*
	With spouse or partner	4756	*28.6*
	With friends or other relatives	3469	*20.9*

Abbreviations: SD = Standard Deviation; NOS = Not Otherwise Specified.

Table 2
Item-level endorsements on the MINI and the LEC-5, n = 16,628.

Psychotic symptom endorsements (MINI)	Count	%
K1. Have you ever believed that people were spying on you, or that someone was plotting against you, or trying to hurt you? [Persecutory delusions]*	12,782	*76.9*
K2. Have you ever believed that someone was reading your mind or could hear your thoughts, or that you could actually read someone's mind or hear what another person was thinking? [Delusion of mind reading and/or thought broadcasting]	9720	*58.5*
K3. Have you ever believed that someone or some force outside of yourself put thoughts in your mind that were not your own, or made you act in a way that was not your usual self? Have you ever felt that you were possessed? [Passivity phenomena (thought insertion, somatic passivity, and delusion of control)]	9247	*55.6*
K4. Have you ever believed that you were being sent special messages through the TV, radio, newspapers, books or magazines or that a person you did not personally know was particularly interested in you? [Ideas/delusions of reference]	8089	*48.7*
K5. Have your relatives or friends ever considered any of your beliefs odd or unusual? [Odd beliefs/delusions]	12,465	*75.0*
K6. Have you ever heard things other people couldn't hear, such as voices? [Auditory hallucinations]	12,534	*75.4*
K7. Have you ever had visions when you were awake or have you seen things other people couldn't see? [Visual hallucinations]	7240	*43.5*
K8. Did the patient ever exhibit disorganized, incoherent or derailed speech, or marked loosening of associations[1] [Disorganized speech]	11,444	*68.8*
K9. Has the patient ever exhibited disorganized or catatonic behavior[1] [Disorganized or catatonic behavior]	9999	*60.1*
K10. Has the patient ever had negative symptoms, e.g. significant reduction of emotional expression or affective flattening, poverty of speech (alogia) or an inability to initiate or persist in goal-directed activities (avolition)[1] [Negative symptoms]	8113	*48.8*
Trauma type endorsements (LEC-5)		
1. Natural disaster (for example, flood, hurricane, tornado, earthquake)	546	*3.3*
2. Fire or explosion	837	*5.0*
3. Transport accident (for example, car accident, boat accident, train wreck, plane crash)	1777	*10.7*
4. Serious accident at work, home, or during recreational activity	971	*5.8*
5. Exposure to toxic substance (for example, dangerous chemicals, radiation)[2]	206	*1.2*
6. Physical assault (for example, being attacked, hit, slapped, kicked, beaten up)	4833	*29.1*
7. Assault with a weapon (for example, being shot, stabbed, threatened with a knife, gun, bomb)	1819	*10.9*
8. Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)	1195	*7.2*
9. Other unwanted sexual experience	711	*4.3*
10. Exposure to war-zone (in the military or as a civilian)	1066	*6.4*
11. Captivity (for example, being kidnapped, abducted, held hostage, prisoner of war)	419	*2.5*
12. Life-threatening illness/injury	1074	*6.5*
13. Severe human suffering[2]	894	*5.4*
14. Witnessed sudden violent death (for example, homicide or suicide)	2043	*12.3*
15. Witnessed sudden accidental death	1603	*9.6*
16. Caused injury/harm/death you caused to someone else	499	*3.0*
17. Any other very stressful experience[2]	1479	*8.9*

Abbreviations: MINI = Mini International Neuropsychiatric Interview, standard 7.0.2; LEC-5 = Life Events Checklist.

[1] Items K8, K9, and K10 were directly observed by a rater or collected from a medical chart.

[2] Items not included in the final network analysis.

* Phrases in brackets refer to the corresponding psychopathological terminology.

In the network visualization, the nodes from the trauma types and the psychotic symptoms broadly clustered separately from one another, with trauma types grouping in one half of the network and psychotic symptoms grouping in the other half of the network (see Fig. 1).

The nodes with the biggest impact across the two communities, as defined here by magnitude of association, were exposure to a war zone

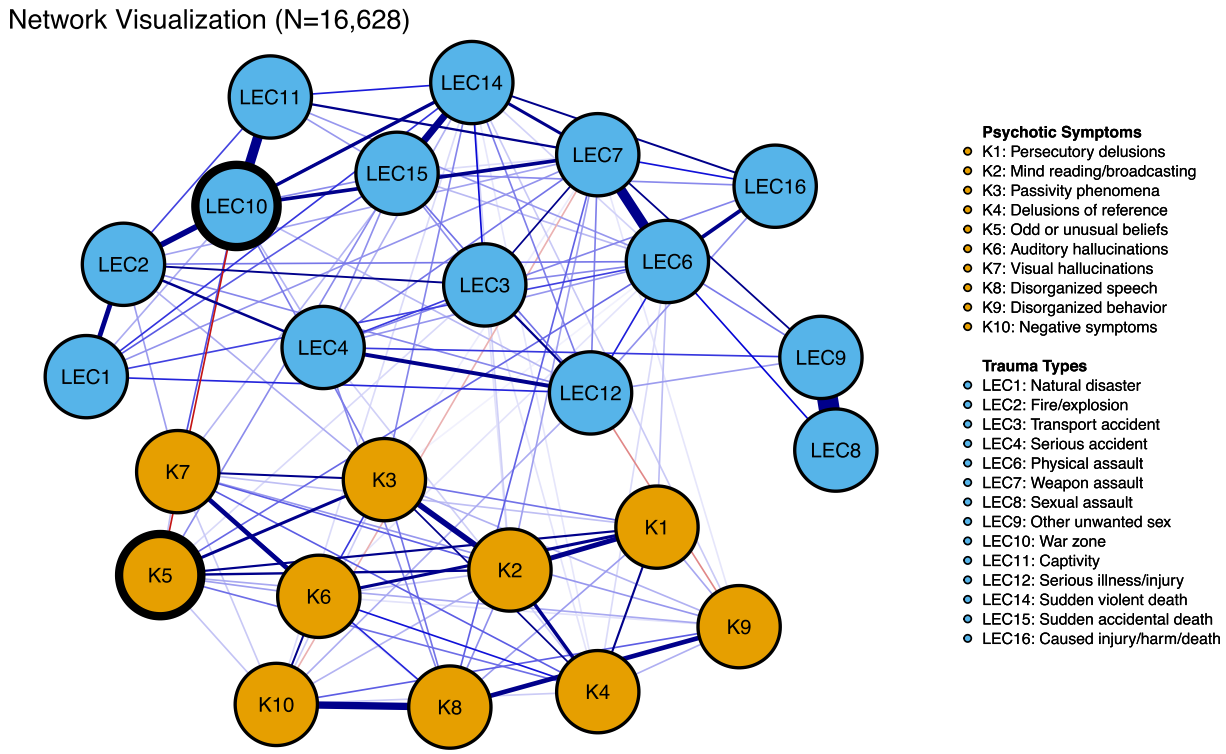

Fig. 1. Network analysis visualization between types of trauma exposure and psychotic symptoms, n = 16,628.
The network visualization shows each variable in the network represented as a node (circle). Blue nodes represent the trauma types and orange nodes represent the psychotic symptoms. Partial correlations between the nodes are edges (the lines between the nodes). Positive partial correlations are depicted with blue edges and negative partial correlations are depicted with red edges. The weight of the edges is represented by edge thickness. The two nodes with the highest bridge strength are depicted with a thick border.(For the colour version of this figure, please see the web version of this article.)

and odd or unusual beliefs (Fig. 2). Exposure to a war zone had the highest bridge strength to the psychotic symptom community and was directly connected to psychotic symptoms of passivity phenomena, odd or unusual beliefs, visual hallucinations, and disorganized speech. Exposure to a war zone also had the highest bridge betweenness and bridge closeness to the psychotic symptom community. Odd or unusual beliefs had the second highest bridge strength in the network and it was the psychotic symptom node with the highest bridge strength. The odd or unusual beliefs node was directly connected to trauma types of experiencing a transportation accident, physical assault, exposure to a war zone, and witnessing sudden accidental death. It was lower on bridge betweenness and bridge closeness relative to the other nodes (5th and 8th, respectively).

Edge weight accuracy was good (see Supplemental Fig. 2). Stability of the bridge centrality statistics was acceptable, with CS-coefficients of 0.44 for bridge strength, 0.36 for bridge betweenness, and 0.36 for bridge closeness (see Supplemental Fig. 3). For the edge difference test and bridge strength difference test, see Supplemental Figs. 4 and 5.

4. Discussion

This exploratory study captures a large and unique sample of adults with psychotic disorders in East Africa, examining whether specific types of trauma are correlated with specific psychotic symptoms and vice versa in a network framework. This work builds on prior network analyses focused on childhood trauma and psychotic symptoms by expanding it to lifetime trauma exposure. Our findings showed that specific types of trauma and psychotic symptoms may interact bidirectionally, including certain trauma types beyond childhood that have not been included in prior studies. We found that exposure to a war zone and odd or unusual belief have the largest effect on psychotic symptoms and trauma exposure, respectively.

In the network visualization, in line with previous research, we found that types of traumatic events and psychotic symptoms broadly grouped together. Past studies have shown that trauma can predispose individuals to additional trauma [28,45,56], thus it is not surprising that trauma types would group together. In addition, psychotic symptoms are known to correlate with one another [37]. Bridge centrality indices showed that war was the most influential node between the trauma and psychotic symptom communities in the network with the highest bridge strength, betweenness, and closeness. Not only was war a critical link in passing information between trauma types and psychotic symptoms (betweenness) and had most the ability to "spread" information to the psychotic symptom community (connectedness), but it also had the largest magnitude of association with the psychotic symptom community and was directly connected to visual hallucinations, odd or unusual beliefs, thought insertion, and disorganized speech.

Given the additional trauma types that are common in war zones for civilians or combatants, such as physical assault, weapon assault, sexual assault, captivity, witnessing death, and causing harm or death to someone else, it is understandable that war had the greatest influence on the psychotic symptom community. Moreover, the network analysis shows that war zone has an independent effect on psychotic symptoms after controlling for these associated trauma types, which further underscores the effect of exposure to a war zone plays across the psychotic symptom community.

Further, it is reasonable to consider that psychotic symptoms may also increase risk of exposure to war events. It is well documented that vulnerable civilian populations such as children or people with psychiatric disorders are left behind when war breaks out as they are incapable of fleeing [44,46] or may be used as weapons of war [17]. It is less clear whether having psychotic symptoms has any influence on becoming a combatant. Because the LEC collapses exposure to a war zone into one event regardless of whether the person is a soldier or civilian, we cannot

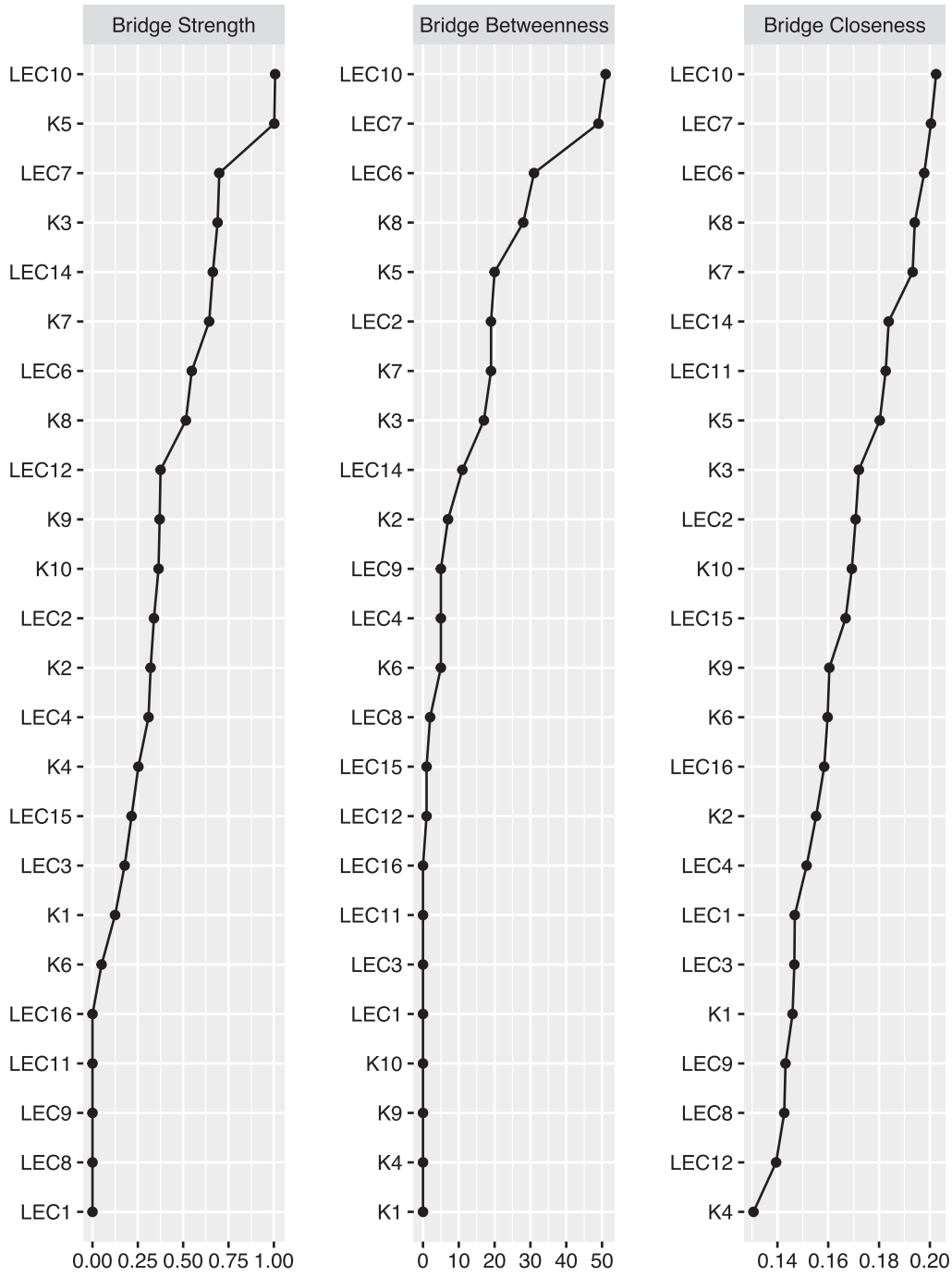

Fig. 2. Centrality indices for bridge strength, bridge betweenness, and bridge closeness.
Bridge centrality indices were ordered from the highest to the lowest for bridge strength, bridge betweenness, and bridge closeness. The node for exposure to a war zone was the highest across all bridge centrality indices.

distinguish between the two experiences. Though it is possible that impaired thinking or lack of capacity to consent due to having a psychotic disorder could also lead someone to become a combatant in a war, there is no literature on this of which we are aware.

The influence of war on psychotic disorders and vice versa is particularly salient in our study sample, given that northern Uganda experienced more than 20 years of civil war starting in the 1980s [3] and a civil war broke out in northern Ethiopia during the period recruitment was underway for this study [23]. These findings are likely applicable to other veteran populations [12] and civilians who have been caught in conflict zones.

From the psychotic symptom community, odd or unusual beliefs was one of the most endorsed symptoms and had the highest magnitude of association with the trauma type community including direct connections to experiencing a transportation accident, physical assault, war, and witnessing sudden accidental death. For example, it is plausible that odd or unusual beliefs could increase the risk of trauma exposure by prompting a person to act erratically and cause them to be involved in violence; likewise, trauma exposure could also trigger odd or unusual beliefs in that the stress of a transportation accident could manifest in

thinking that people were out to get you. The odd or unusual beliefs node played a role in passing information between psychotic symptoms and trauma types (betweenness) and had some ability to spread information to the trauma type community (connectedness), however less so than its bridge strength.

This study contributes to the field in its consideration of trauma exposure over the life course and its interplay with psychotic symptoms. While the majority of studies have looked at the role that childhood trauma and adversity play in psychotic disorders and psychotic symptoms [4,15,47], there is limited but growing literature on the part that adult life events play in psychotic disorders [5,16]. Our network analysis contributes to the literature in that it expands the timeframe of trauma to exposure that could have occurred at any point in a participant's life. By utilizing the LEC, we do not have temporality and may have missed some trauma exposures commonly included in childhood trauma scales such as not having enough to eat growing up or being told hurtful things by a family member. However, using the LEC allowed us to examine a broader scope of trauma types, such as experiencing a natural disaster or transportation accident over the lifespan, thus considering the role of lifetime trauma on psychotic symptoms.

This study builds on previous research on trauma exposure and psychotic disorders in Sub-Saharan Africa and expands it in new directions. There have been some studies on the association between trauma and psychotic disorders in Africa, such as [1] ([1,38] [38]. The majority of network analyses on trauma exposure and psychotic symptoms, however, come from European and North American samples, and we believe this is the first such network analysis in Africa. Future research could compare network analyses conducted in "Western" settings to those in Africa to determine whether there are differences in the findings across settings.

4.1. Limitations

There are limitations of the study. Network analysis is a unique framework that can identify patterns of interaction; however, it cannot establish a causal link between symptoms or traumatic events and psychotic symptoms without additional evidence. In addition, we would need further detail about the content and characteristics of "odd and unusual beliefs" as this symptom is non-specific and may be interpreted in various ways, thus limiting the conclusions we can draw about it. Further probing or specifiers around this question could aid in establishing consistency in participants' response options. Future research should consider factors that may further play a role in the relationship between the nodes such as mediators, effect modifiers, and measures on dissociative experiences, or independently on the development of symptoms and traumatic experiences. In addition, because this data is measured at one point in time and is not longitudinal, it cannot capture within-person effects of psychiatric symptoms prospectively as they fluctuate over time [19]. There also may be effects of recall bias in that memories of symptoms or exposures to trauma may be less accurate if participants experienced them a long time ago vs. in the recent past, or according to the level of distress the events might have caused. The stability of some of the centrality indices was adequate but not excellent, so future research should aim to replicate these results.

5. Conclusion

In this study we demonstrated strong and numerous connections between specific types of trauma that can be experienced over the life course and psychotic symptoms. Being exposed to a war zone may increase the risk of psychotic symptoms and vice versa. In addition, experiencing odd or unusual beliefs may make patients more prone to traumatic events and vice versa. Assessing and addressing whether a patient with a psychotic disorder has been exposed to a war zone or has odd or unusual beliefs by a clinician may be areas of intervention to decrease triggering further exposure to trauma or psychotic symptoms. Clinically, this work reaffirms the importance of trauma-informed care for patients with psychotic disorders [24].

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Code availability

The code for this study is available at Open Science Framework at: https://osf.io/sbyne/

Author contributions

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work.

- Formulation of the research question: AS, SM, SS
- Conducting the analyses: AS and SM, with code review by AI
- Creation of tables and figures: AS and SM
- Interpretation of the data: AS, SM, and EG
- Data acquisition: EG, DA, MA, LA, BG, SG, SMK, EK, JK, RMM, CPN, CRJCN, LO, RES, ST, KCK

2. Drafting the work or reviewing it critically for important intellectual content.

- Writing (original draft): AHS
- Writing (reviewing and editing): SM, EG, AI, DA, MA, LA, BG, SG, SMK, EK, JK, RMM, CPN, CRJCN, LO, RES, ST, KCK, SS

3. Final approval of the version to be published.

AS, SM, EG, AI, DA, MA, LA, BG, SG, SMK, EK, JK, RMM, CPN, CRJCN, LO, RES, ST, KCK, SS

4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

AS, SM, EG, AI, DA, MA, LA, BG, SG, SMK, EK, JK, RMM, CPN, CRJCN, LO, RES, ST, KCK, SS

CRediT authorship contribution statement

Anne Stevenson: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Supriya Misra:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Engida Girma:** Writing – review & editing, Investigation, Formal analysis. **Adela-Maria Isvoranu:** Writing – review & editing, Methodology, Formal analysis. **Dickens Akena:** Writing – review & editing, Investigation, Funding acquisition. **Melkam Alemayehu:** Writing – review & editing, Investigation. **Lukoye Atwoli:** Writing – review & editing, Investigation, Funding acquisition. **Bizu Gelaye:** Writing – review & editing, Funding acquisition. **Stella Gichuru:** Writing – review & editing, Project administration, Investigation. **Symon M. Kariuki:** Writing – review & editing, Investigation, Funding acquisition. **Edith Kamaru Kwobah:** Writing – review & editing, Project administration, Investigation. **Joseph Kyebuzibwa:**

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Declaration of competing interest

None.

Data availability

All data will be deposited and made available through the National Institute of Mental Health Data Archive at these sites: https://nda.nih.gov/edit_collection.html?id=3805; https://nda.nih.gov/edit_collection.html?id=4538; and https://nda.nih.gov/edit_collection.html?id=4539.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2024.152504.

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