Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Cross-cultural investigation of COVID-19 related acute stress: A network analysis

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ABSTRACT

The outbreak of the COVID-19 pandemic has confronted humanity with an ongoing biopsychosocial stressor, imposing multifaceted challenges to individuals and societies. Particularly, the pandemic reflects an ongoing, potentially life-threatening danger to self and others, which may instigate acute stress symptoms (ASS). This study utilized a network framework to assess cross-national ASS a short time following the initial COVID-19 outbreak.

Three samples of adult participants from China, Israel, and Switzerland completed a self-report assessment of acute stress symptoms. Network analyses were utilized to uncover the phenotype and dynamics of different ASS in these three countries.

The ASS network analyses revealed extensive connections in all networks and reflected the structure of ASS. The centrality indexes in all networks were from the hyperarousal cluster. “Feeling jumpy” was the node with the highest strength centrality in the Israeli sample and “physiological reactivity” was the item with the highest centrality in the Swiss sample. In the Chinese sample, the item with the highest centrality was “feeling alert to danger."

The findings reveal that despite some variations, the overall clinical picture of ASS in response to the COVID-19 pandemic is universal. These findings highlight the centrality of hyperarousal symptoms, presumably reflecting its significance for clinical interventions.

1. Introduction

Since December 2019, the world has been facing the outbreak of the COVID-19 pandemic **(COVID-19 in short).** Aside from the emergency health related challenges (World Health Organization, 2020), the pandemic has confronted humanity with momentous economic, social, psychological, and political challenges. Unsurprisingly, the psychosocial toll of the pandemic has been acknowledged as the “second tsunami” of COVID-19 (Dutheil et al., 2020). Indeed, growing findings have demonstrated the psychosocial ramifications of the pandemic, including elevated levels of distress (Bachem et al., 2020; Lai et al., 2020), fear (Lee et al., 2020), general anxiety (Hyland et al., 2020; Shevlin et al., 2020), depression (González-Sanguino et al., 2020), as well as reports of somatic symptoms (Shevlin et al., 2020), and health related and economic anxiety (Bareket-Bojmel et al., 2020). These findings have uncovered the global psychosocial toll of the COVID-19 pandemic, which has brought about major challenges for mental health practitioners, emphasizing the need to develop quick, effective, and mass-scale crisis interventions to sustain psychosocial functioning and well-being (Chen et al., 2020; Duan and Zhu, 2020).

The stressor of the COVID-19 pandemic is characterized as continuous, potentially life-threatening to self and others, and may therefore be considered a potentially traumatic experience (Hyland et al., 2020; Shechter et al., 2020). Similar to other traumatic experiences, the pandemic outbreak was essentially unexpected, mostly uncontrollable, while simultaneously involving ongoing major alterations to daily life. These characteristics denote prolonged exposure to an ongoing stressor that, especially during initial pandemic peaks, may instigate acute stress

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reactions (Shechter et al., 2020; Xiao et al., 2020; Zhang et al., 2020). Acute stress reaction or acute stress symptoms (ASS) are conditions described in the DSM-5 and ICD-10 as reflecting short-term responses to traumatic experiences, occurring within three days and lasting up to one month following the traumatic **event/s.**[1] Conventionally, this condition involves intrusive, dissociative, and avoidant symptoms, as well as negative mood (American Psychiatric Association, 2013). Initial findings have already documented ASS as a response to the COVID-19 pandemic among self-isolated adults (Xiao et al., 2020), healthcare workers (Shechter et al., 2020), and school-aged children (Zhang et al., 2020).

Although piling evidence has indicated that individuals may experience ASS due to COVID-19, very little is known about the clinical presentation of this condition in terms of the connections between symptoms and whether ASS encapsulates such responses on a global level. Moreover, very little is known regarding which symptoms are fundamental in activating others or whether certain symptoms are more central in activating the web of interconnected symptoms. Understanding these aspects may reveal important clinical information and shed light on the clinical presentation of ASS as a result of COVID-19.

Additionally, a question arises as to whether ASS is generally universal, or if it is instead prone to individual and/or cultural differences. Furthermore, there may be variations instigated by additional stressors that are associated with how countries are responding to the pandemic. For example, some findings have demonstrated variations between different cultural or ethnic groups in the acute stress intensity and symptoms (Anshel et al., 2009; Xu et al., 2011). Additionally, local authorities have taken different actions in the face of COVID-19, presumably leading to different public reactions, as well as divergent health, economic, and psychosocial challenges. Such differences may, therefore, affect ASS in relation to the pandemic. Hence, this study aims to test a cross-national comparison of the phenotype of COVID-19 ASS.

Using a network analysis enables an examination of the phenotype and the dynamics of different phenomena (Greene et al., 2018; McNally, 2016). A growing body of literature has employed this method to exploratively map the symptoms of mental health disorders and the ways symptoms interact with one another, thus constructing the clinical picture of psychopathology. The underlying assumption of the network analysis is that there is not necessarily a single original latent factor of mental health disorders that initiates symptoms, but rather, some symptoms may instigate other symptoms through a myriad of biological, psychological, and societal mechanisms (Borsboom, 2017). In the face of a global crisis, such as the COVID-19 pandemic, network analysis is advantageous in its ability to exploratively uncover the "clinical picture" of ASS. Of particular interest are the "central symptoms," which are identified by the analysis as retaining the strongest associations with the majority of the other symptoms, thereby activating them (Barrat et al., 2007). Identifying these symptoms may assist in designing early interventions that would explicitly target these central symptoms (Bryant et al., 2017).

To date, substantial efforts have been dedicated to implementing a network analysis in the study of PTSD (Afzali et al., 2017; Armour et al., 2017, 2020; Cero and Kilpatrick, 2020; Greene et al., 2018; McNally et al., 2017; Price et al., 2019; Spiller et al., 2017) and complex PTSD (Gilbar, 2020; Knefel et al., 2016, 2019). Much less is known regarding the network of ASS. A few findings, however, have provided an initial insight. One study presented a network comparison of acute and chronic stress symptoms following an injury, showing that intrusive and arousal symptoms were central during the acute phase and that the network connectivity was stronger 12 months after the traumatic experience (Bryant et al., 2017). The findings of a second study, which examined acute and chronic posttraumatic responses among assault survivors, revealed a similar finding, with recurrent or distressing recollections being central to predicting the development of PTSD (Haag et al., 2017). Considering the multifaceted nature of the pandemic-related stressors, a different symptom network may arise.

Though unfortunate, the COVID-19 pandemic provides a unique opportunity to assess universal responses to a similar ongoing stressor, while examining international differences in related acute symptoms. For this purpose, this study explored cross-national differences in the phenotype of ASS related to COVID-19 a short time after the pandemic outbreak pandemic. During the initial peak of COVID-19, data were collected in three countries (i.e., China, Israel, Switzerland) which presumably reflect substantially different cultures. A comparison between the network of ASS of these three countries was conducted in terms of symptom connections and the centrality index.

2. Methods

2.1. Participants and procedure

This study was conducted during the initial peak of the COVID-19 outbreak in three different countries: China, Israel, and Switzerland. Since the timing of the outbreak differed between these countries, the study was initiated in China, and then continued in Israel and Switzerland. In all three sites, data collection took place while most of the population was under quarantine or lockdown (which was imposed by the Chinese and Israeli governments, and recommended by the Swiss government), with educational institutions closed or with lessons conducted remotely, and most people were either not working or working from home. In China, data collection took place from January 27–30, 2020. In the initial stage of data collection, there were 4515 verified cases of COVID-19 and 106 deaths **in China**. By the end of data collection, there were 9692 verified cases and 213 deaths. In Israel, data collection took place from March 30 to May 16, 2020. During the initial stage of data collection, there were 4695 verified cases of COVID-19 and 16 deaths **in Israel**. By the end of data collection, there were 16,607 verified cases and 268 deaths. In Switzerland, data collection commenced on April 24, 2020, when there were 29,014 verified cases of COVID-19 and 1496 deaths. By the end of data collection on May 23, 2020, there were 30,628 verified COVID-19 cases and 1677 deaths **in Switzerland**.

Convenience samples of 1050 Chinese, 639 Israeli, and 595 Swiss participants were recruited via social media (e.g., Facebook, WeChat in China) and a snowball technique. **The study was advertised through personal and professional networks. In Israel and Switzerland, data collection also included Facebook advertisement targeting ages 30 and above. In China, data was collected via WeChat platform (a free messaging and calling app that is widely used in China) and were compensated with electronic credits (1–2 CNY) via WeChat's 'red envelope' feature.** Participants were invited to participate in a study aiming to uncover psychosocial coping with challenges due to COVID-19. Questionnaires were distributed electronically in local languages (i.e., Chinese in China, Hebrew and Arabic in Israel, and German in Switzerland), using a website "www.wjx.cn" website, Qualtrics, or Unipark Software. Inclusion criteria were a) above the age of 18, and b) fluent in the local language. The study was conducted in accordance with the latest version of the Declaration of Helsinki and approved by the Institutional Review Boards in each country. Informed consent was obtained from each participant after the procedure had been fully explained.

2.2. Measures

Demographic data collected included gender, age, education, employment situation, income (in Israel and China), rural or urban area (in Switzerland), number of persons in household, number of children

[1] Considering the differences in defining acute stress reaction/disorders in the current classification systems (i.e., DSM5 and ICD-11), a neutral term 'acute stress symptoms' was chosen.

(Israel), COVID-19 risk group yes or no (in Switzerland).

In Israel and Switzerland, ASS was assessed using the Acute Stress Disorder Scale (ASDS; Bryant et al., 2000). The ASDS, adapted in this study to specifically refer to COVID-19, assesses four ASS clusters including dissociation ("emotional numbness", "things seem unreal"), re-experiencing ("sense of re-experiencing", "intrusive memories"), avoidance ("avoid reminders of COVID-19", "avoid thinking about COVID-19"), and arousal symptoms ("feeling irritable", "difficulty concentrating"), for a total of 19 symptoms. Participants were asked to rate, on a five-point Likert scale ranging from 1 (not at all) to 5 (very much), the frequency that they experienced each of the 19 symptoms since the COVID-19 outbreak. **The German translation of the ASD scale was validated with a Swiss sample by Helfricht and colleagues (2009). The Hebrew and Arabic translation was conducted by three bi-lingual translators and reviewed by two trauma experts.** Previous findings revealed the scale's validity (Bryant et al., 2000). Cronbach's alpha for the Israeli sample was 0.89, and for the Swiss sample was 0.90, indicating high reliability.

In China, ASS was assessed several months before Israel and Switzerland, using a scale consisting of 14-items from the DSM-5 Acute Stress Disorder Diagnostic Criteria B (American Psychiatric Association, 2013). These items were rated on a 2-point scale (0 = no, 1 = yes). **The Chinese version of the Diagnostic and Statistical Manual of Mental Disorders** (American Psychiatric Association, 2014)**, was translated and collated by the working committee of Diagnostic Criteria from DSM-5 in simplified character Chinese.** The DSM-5 criteria in relation to ASS were found to have good validity in a previous study (McKinnon et al., 2016). In the current study, the questionnaire exhibited good reliability (Cronbach's alpha = 0.85).

2.3. Data analyses

2.3.1. Regularized partial correlation networks across the Israeli and Swiss samples

Network Estimation. Symptom networks were estimated for all symptoms of ASS using regularized partial correlation models in the R-package qgraph (Epskamp et al., 2012). This method presents the unique and independent relationships between the symptoms. Symptoms in a network model are called nodes and the associations between nodes are called edges. The network was weighted and undirected due to the cross-sectional nature of the study. Questionnaire data were answered at an ordinal scale, thus, we estimated a polychoric matrix. We estimated partial pairwise correlation parameters between all nodes, through a Gaussian Graphical Model (GGM) as used by Knefel (Knefel et al., 2019).

Visualization with the Graphical Lasso. We used the graphical least absolute shrinkage and selection operator (glasso; implemented in qgraph), which visualizes sparse networks using partial correlations and considers the ordinal scale of the questionnaires. This method directly estimates the inverse of the covariance matrix (Friedman et al., 2008). It shrinks small edges and many parameters to zero by estimating a penalized maximum likelihood solution based on the Extended Bayesian Information Criterion (EBIC; Foygel and Drton, 2010). For ease of visual comparison, the networks were restricted to a consistent "average layout," presented across the two samples.

Network stability. We examined the stability of the individually estimated networks, including estimating 95% confidence intervals around the edge weights and estimating a correlation-stability coefficient for strength centrality. More information regarding the network analysis technique can be found in a tutorial (Epskamp et al., 2018).

2.3.2. Regularized binary data networks in the Chinese sample

Network Analyses. The Chinese network was based on the ASS binary questionnaire. Considering the binary nature of the data, the appropriate PRMF model adapted to our data was the generalization of the Ising model presented in the IsingFit R-package (Van Borkulo et al., 2014). This approach is based on a probabilistic model that combines the log-linear model estimations with model selection, based on the EBIC, to identify conditional relations between variables in a way that can be used in a network. The model uses the threshold parameters (frequency of each binary variable), pairwise associations, and a penalty parameter based on the sample size to shrink small coefficients to zero. The smaller the sample size, the higher the penalty and the more associations that are reduced to zero. This method has been demonstrated to be highly effective in estimating weighted networks from binary data with simulated and real data (for more details see Van Borkulo et al., 2014). The R-package qgraph (Epskamp et al., 2012) was used to visualize the network. Thicker edges represent stronger relations between nodes. The positioning of the nodes in relation to one another is based on the layout proposed by Fruchterman and Reingold (1991) and reflects the centrality of nodes and the strength of edges in the global network. Nodes that are more strongly related are depicted closer together.

3. Results

Table 1
Demographic characteristic by study group.

	Chinese sample (n = 1050)	Swiss sample (n = 582)	Israeli sample (n = 639)	Chi square/ Independent sample *t*-test
Gender				
Female	689 (65.6%)	439 (73.8%)	534 (84.1%)	Chi square (4) = 81.86
Male	361 (34.4%)	156 (26.2%)	101 (15.9%)	$p < .001$
Age[a] (*M, SD*)	28.93, 9.66	43.15, 14.77	47.25, 14.38	ANOVA F (2) = 70.42 $p < 0.001$[b]
Education level				
Primary/middle school	7 (0.7%)	157 (26.4%)	3 (0.5%)	Chi square (4) = 499
Highschool	85 (8.1%)[c]	98 (16.5%)	42 (6.6%)	$p < .001$
Academic	958 (91.3%)	340 (57.1%)	587 (92.9%)	
ASS (*M, SD*)	**1.76, 2.63**	**1.68, 0.56**	**2.12, 0.64**	

[a] Age range: 18–99 years.
[b] Scheffe post-hoc analyses showed that the Chinese sample was significantly younger than the Israeli ($p < .001$), and Swiss ($p < .001$) samples. The Israeli and Swiss samples were not different in mean age ($p = .62$).
[c] This category in the Chinese sample refers to middle or high school.

3.1. Demographic characteristics of the Chinese, Israeli, and Swiss samples

The background variables of the three samples are depicted in Table 1. As can be seen, some differences were found between the samples in age, gender, education level, and the number of people in a household. Specifically, while the Israeli and Swiss samples included more women, the Chinese sample included more men. Additionally, the Chinese sample was significantly younger than the Israeli and Swiss samples, which were not different from each other in mean age. Finally, the education level was higher in the Chinese and Israeli samples,

compared to the Swiss sample.[2]

3.2. Regularized partial correlation across the Israeli and Swiss networks

3.2.1. Network estimation

Item numbers of the Israeli and Swiss samples are depicted in Table 2. To enhance the visual comparison of edges, we estimated the average layout of the Israeli and Swiss networks (for layout see Fig. 1). In the network of ASS symptoms in Israel, 86 of 171 possible edges were non-zero (50.1%). In the Swiss network, 90 of 171 possible edges were non-zero (53.1%). This determined that the symptoms had extensive connections with one another in both samples. The visual inspection of the networks exhibited a few consistent edge similarities across the two samples between item 11 (avoid talking about COVID-19) and item 12 (avoid reminders of COVID-19). Additionally, items 3 (things seem unreal) and 4 (an altered sense of reality and self) of the dissociation scale were highly associated in both networks. Items 10 (avoid thinking about COVID-19) and 11 (avoid talking about COVID-19) were also highly associated in both networks, although among the Swiss sample it was more substantial.

There were unique connections in each network. In the Swiss network, item 18 (feeling jumpy) was strongly related to both item 17 (feeling more alert to danger) and item 19 (physiological reactions). In the Israeli sample, there was a relatively lower number of substantial connections among the symptoms. In this network, the strongest connection was between items 15 (feeling irritable) and 18 (feeling jumpy), both of which reflect arousal symptoms.

3.2.2. Network inference

To confirm the visual similarity of networks, we used Spearman correlations of edge-weights. The analysis showed that the accuracy of the edges in the Israeli (0.75, 95% CI [0.67, 1.00]) and Swiss (0.67, 95% CI [0.59, 0.75]) samples were satisfactory. Item 18 (feeling jumpy) was the node with the highest strength centrality in the Israeli sample and item 19 (physiological reactivity) was the item with the highest centrality in the Swiss sample, both reflecting arousal symptoms.

3.2.3. Network stability

The stability analyses relied on the correlation-stability coefficient and the bootstrapped confidence intervals (CIs) around the estimated edges. The results of the CIs showed that the edge-weights were moderately large. In addition, the results showed moderate accuracy and the robustness of our networks. Small edges should be inferred cautiously. Approximately, 40% of the Israeli and 30% of the Swiss networks' non-zero edges had CIs that did not contain zero. However, in both samples, the CIs of the most intense edges did not coincide with the CIs of weak edges. The CIs were moderately large around the edge weights (Fig. 3). This indicator of the network estimation was found to be moderate, reflecting moderate accuracy. Therefore, the results of the stability analyses should be interpreted cautiously. The stability coefficient for the strength centrality metric was above the suggested 0.5 cutoff for strong stability for the Israeli sample (0.75, 95% CI [0.67, 1.00]) but lower for the Swiss sample (0.50, 95% CI [0.43, 0.57]). The correlation of the original strength centrality with the strength centrality in subsamples was high, which is crucial as it was also high following the procedure of removing a substantial number of participants (Fig. 3), meaning that the strength estimate can be considered stable in both samples. Fig. 4 display the edges that significantly differ from one another.

3.2.4. The Chinese ASS network

Item numbers of the Chinese sample are depicted in Table 2. The network constellation of ASS is presented in Fig. 2. In the network, 100% of the edges were estimated above zero. The highest edge-weights included item 3 (sense of re-experiencing) and item 14 (feeling irritable). Also, item 7 (difficulty remembering) and item 8 (avoid thoughts and emotions about COVID-19) were strongly related. The item with the highest centrality was item 13 (feeling more alert to danger). The item with the lowest centrality was item 5 (inability to experience positive emotions).

4. Discussion

This study utilized a network perspective to assess ASS among participants from three countries facing the initial outbreak of COVID-19. The findings of this study revealed that, although not identical, overall a similar pattern of ASS emerged in China, Israel, and Switzerland. Additionally, in all three countries, hyperarousal symptoms emerged as central, thus potentially holding clinical implications. Overall, these findings suggest that, although local pandemic-related stressors and cultural differences are present, ASS in response to the pandemic is similar to a certain extent.

More specifically, the three countries included in this study differed in their management of the virus outbreak, which could have affected consequent reactions. China was the first country in the world to combat the pandemic, whereas the outbreaks in Israel and Switzerland took place a few months later, when there was some understanding of the medical manifestations and its potential risks. In this sense, it is possible that the stressors related to COVID-19 were somewhat anticipated in Switzerland and Israel. Additionally, the governments' reactions to the pandemic through the various healthcare systems, economic considerations and actions, and the sociopolitical climate, varied greatly (Airhihenbuwa et al., 2020; Bruns et al., 2020), and therefore may have also affected the different population's reactions (Frey et al., 2020). Cultural differences in regards to how ASS are expressed have also been documented elsewhere (Anshel et al., 2009; Xu et al., 2011). Indeed, such distinctions could have led to various patterns of findings among these three countries.

Nevertheless, the current findings imply that the pandemic can be generally and universally experienced as a traumatic stressor, instigating ASS. That is, the findings demonstrate similar correlations between symptom profiles, network structures, as well as centrality approximations. Although a direct comparison was only applicable between the Israeli and Swiss samples, the current findings imply that the overall pattern of ASS is relatively alike in all three countries. First, symptoms of hyperarousal were consistently shown to be highly linked – in China, Israel, and Switzerland. In both the Israeli and Swiss samples, connections emerged between avoidant symptoms. A somewhat different pattern appeared in the Chinese sample, where avoidance of memories, thoughts, and feelings was linked to a difficulty to remember details about the epidemic (reflecting dissociation). These findings show that, despite some variations, the clinical picture of ASS following the

[2] To examine the potential effects of sex on the report of acute stress symptoms, a series of analyses of covariance (ANCOVA) were utilized for each of the three countries. The dependent variable was defined as ASS. Sex was defined as the independent variable, and age, education level, and level of exposure to COVID-19-related stressors (e.g., got infected, a close person got infected, experienced quarantine, etc.) were defined as covariates. In Israel, the ANCOVA did not reveal a significant effect of sex (women: mean = 2.15; SD = .64; men: mean = 1.99; SD = .66), F(2,717) = 2.85, p = .059. Age (p = .77), education level (p = .23), and COVID-19-exposure (p = .49) were not significant. In Switzerland, the ANCOVA revealed a significant effect of sex (women: mean = 1.73; SD = .58; men: mean = 1.52; SD = .47), F(1,581) = 17.01, $p < .001$. Age (p = .66), and COVID-19-exposure (p = .34) were not significant, however, education level significantly explained sex differences in the report of ASS, F(1,581) = 7.57, p = .006. The effect size was small ($\eta^2 = 0.03$). In China, the ANCOVA did not reveal a significant effect of sex (women: mean = 1.82; SD = 2.44; men: mean = 1.66; SD = 2.95), F(1,1044) = 0.49, p = .48. Age (p = .92), education level (p = .15), and COVID-19-exposure (p = .13) were not significant. As can be seen, although some sex differences were found in Switzerland, the effect size was small. No sex differences were found in Israel or in China.

Table 2
Item numbers of the Israeli and Swiss ASS.

Israel and Switzerland			China		
Item number	Item	ASS	Item number	Item	ASS
1	Since the COVID-19 outbreak, did you ever feel numb or distant from your emotions?	Emotional numbness	1	Terrible thoughts or pictures about COVID-19 suddenly enter my mind	Intrusive thoughts
2	Since the COVID-19 outbreak, did you ever feel in daze?	Feeling in a daze	2	I often have terrible dreams about COVID-19	Nightmares
3	Since the COVID-19 outbreak, did things around you ever feel unreal or dreamlike?	Things seem unreal	3	My behaviors or emotional reactions make it feel like I am always in the situation of the epidemic (e.g., seeing pictures of the epidemic makes me feel like I am in the situation)	Sense of re-experiencing
4	Since the COVID-19 outbreak, did you ever feel distant from your normal self or like you were watching it happen from outside?	An altered sense of reality and self	4	Reminders of the epidemic cause terrible/prolonged psychological reaction or obvious physical reactions	Distressed by reminders
5	Have you been unable to recall important aspects of COVID-19?	Difficulty remembering	5	Since the COVID-19 outbreak, I find it hard to feel positive emotions (e.g., happiness or satisfaction)	Inability to experience positive emotions
6	Do memories of the COVID-19 outbreak keep entering your mind?	Intrusive memories	6	Since the COVID-19 outbreak, I feel alienated from my surroundings (e.g., I often see myself from other's respective)	An altered sense of reality and self
7	Have you had bad dreams or nightmares about COVID-19?	Nightmares	7	Difficulty remembering the details of COVID-19	Difficulty remembering
8	Have you felt as if the COVID-19 outbreak was about to happen again?	Sense of re-experiencing	8	Try to avoid memories, thoughts or feelings related to COVID-19	Avoid thoughts and emotions about COVID-19
9	Do you feel very upset when you are reminded of COVID-19?	Distressed by reminders	9	Try to avoid the people, activities or places related to COVID-19	Avoid reminders of COVID-19
10	Have you tried not to think about COVID-19?	Avoid thinking about COVID-19	10	Since the COVID-19 outbreak, I have difficulty concentrating (e.g., distracted while watching TV)	Difficulty concentrating
11	Have you tried not to talk about COVID-19?	Avoid talking about COVID-19	11	Since the COVID-19 outbreak, I have difficulty falling asleep or wake up easily	Difficulty sleeping
12	Have you tried to avoid situations or people that reminded you of COVID-19?	Avoid reminders of COVID-19	12	Since the COVID-19 outbreak, I feel jumpy or easily startled	Feeling jumpy
13	Have you tried not to feel upset or distressed about COVID-19?	Avoid emotions related to COVID-19	13	Since the COVID-19 outbreak, I feel super alert (e.g., examining the people or surroundings to ensure safety)	Feeling more alert to danger
14	Have you had trouble sleeping since the COVID-19 outbreak?	Difficulty sleeping	14	Since the COVID-19 outbreak, I feel anxious or easily irritable	Feeling irritable
15	Have you felt more irritable since the COVID-19 outbreak?	Feeling irritable			
16	Have you had difficulty concentrating since the COVID-19 outbreak?	Difficulty concentrating			
17	Have you become more alert to danger since the COVID-19 outbreak?	Feeling more alert to danger			
18	Have you become jumpy since the COVID-19 outbreak?	Feeling jumpy			
19	When you are reminded of COVID-19, do you sweat or tremble or does your heart beat faster?	Physiological reactions			

pandemic was mostly similar.

Additionally, the findings of this study imply that the most central ASS are hyperarousal symptoms. This finding was consistent among the Chinese, Israeli, and Swiss samples. Such results are in line with Bryant and colleagues' (2017) findings, which showed hyperarousal symptoms as being central during the acute phase following a traumatic injury. In a network central symptoms are thought to entail the highest number of edges with other symptoms, possibly reflecting causal connections (Greene et al., 2018; McNally, 2016). As such, early interventions following traumatic experiences, such as debriefing, trauma-focused cognitive behavioral therapy, prolonged exposure, and eye movement desensitization (Koucky et al., 2012; McNally et al., 2003; Ponniah and Hollon, 2009) may benefit from assessing and targeting acute hyperarousal symptoms. Nevertheless, it is important to point out that centrality may not always imply clinical causality (Fried et al., 2018), thus further research is necessary in order to validate the causal centrality of hyperarousal symptoms for ASS relating to the COVID-19 pandemic.

A related, yet different, question arises as to whether the centrality of hyperarousal symptoms at the acute phase is also predictive of chronic stress. Although some studies have shown conflicting results, most findings do not support the notion that individuals who demonstrate ASS are at a greater risk of developing PTSD (Bryant, 2011). Relatedly, the majority of these examinations do not test which combination of acute symptoms holds the strongest predictive value. As presented earlier, previous network investigations have suggested that recurrent or distressing recollections of the traumatic event were the strongest predictors of later PTSD (Haag et al., 2017). However, with an ongoing stressor, such as the COVID-19 pandemic, the clinical symptomatic pattern and the predictability of ASS may differ from those related to a single traumatic event. Therefore, more research is needed in order to uncover the long-term pattern and connectivity of acute and chronic stress symptoms in the face of a unique stressor such as the COVID-19 pandemic.

Several limitations should be considered when interpreting the findings of this study. First, and most importantly, the unpredictable nature of the pandemic affected the research methods, as it was initiated with the Chinese sample and only a few months later was combined with the Swiss and Israeli counterparts. Consequently, the scales used to measure COVID-19-related ASS were not identical, which imposed limitations regarding the comparability of the findings. Although all Moreover, while we regard ASS to adequately capture mental health consequences during the initial outbreak of COVID-19, it should be

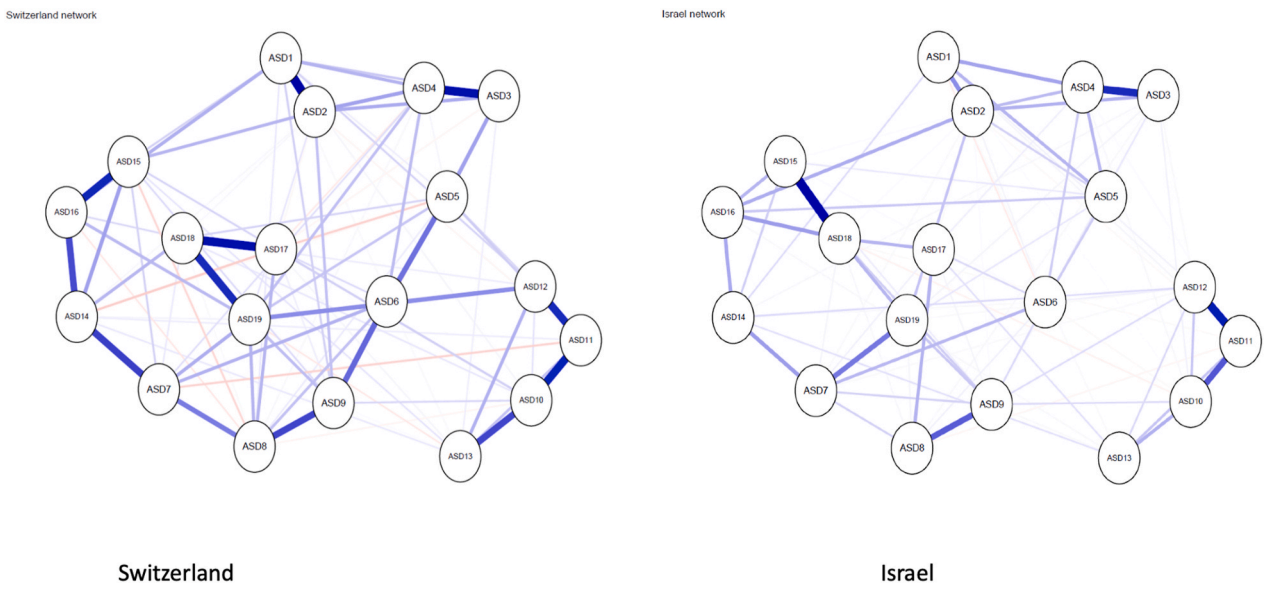

Fig. 1. Network of ASD symptoms in Israel and Switzerland using average spring layout. Nodes represent ASD items, and edges regularized correlation with LASSO penalty. Distances among nodes and thickness of edges relate to the size of their partial correlations. Blue edges indicate positive relations and red edges indicate negative relations. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

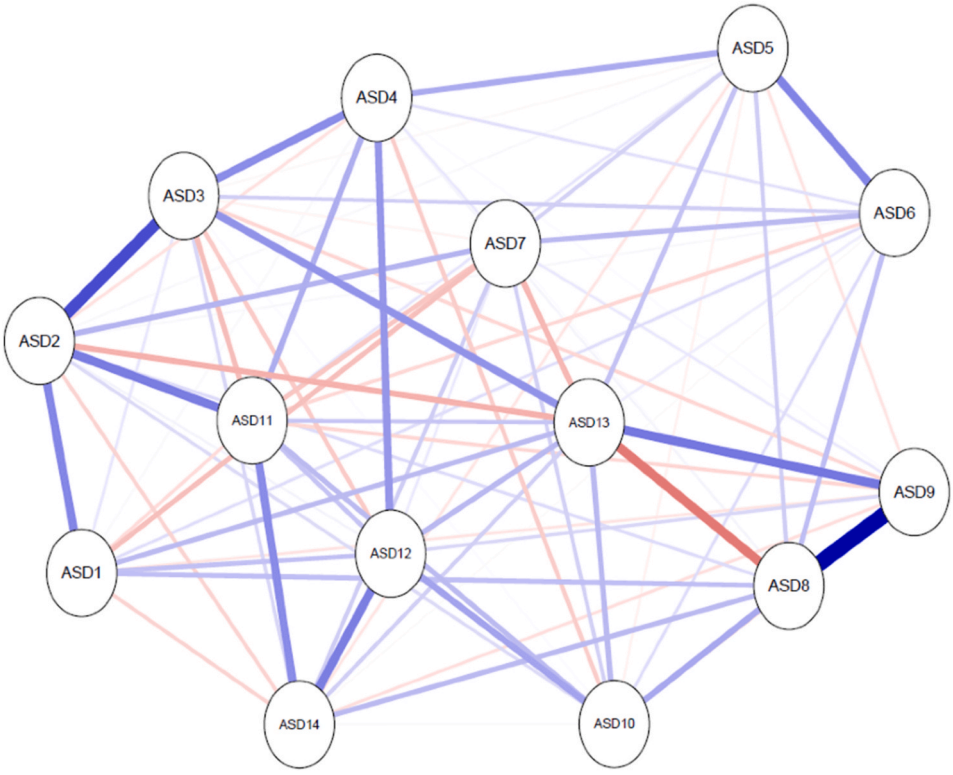

Fig. 2. Network of ASD symptoms in China. Nodes represent ASD items, and edges regularized partial correlation with Fruchterman-Reingold methodology. Distances among nodes and thickness of edges relate to the size of their partial correlations. Blue edges indicate positive relations and red edges indicate negative relations. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

considered for further assessments that adjustment disorder may be a more appropriate outcome, as only certain risk groups experience life danger during the pandemic. Adverse life changes and restrictions are typical triggers for adjustment disorder symptoms.

Additionally, the characteristics of the three samples were somewhat different, presumably imposing additional limitations on the comparability of the findings. Future studies should further examine the role of background variables for ASS and potential cultural differences that are instigated by these factors. Another limitation concerns the lack of potential psychopathological comorbidity and exposure to previous traumas. Future investigations should, therefore, include covariates that may affect ASS. Particularly, future studies should test whether and how do mental disorders prior to pandemics predict pandemic-related ASS. Finally, it should be noted that although all of the questionnaires utilized

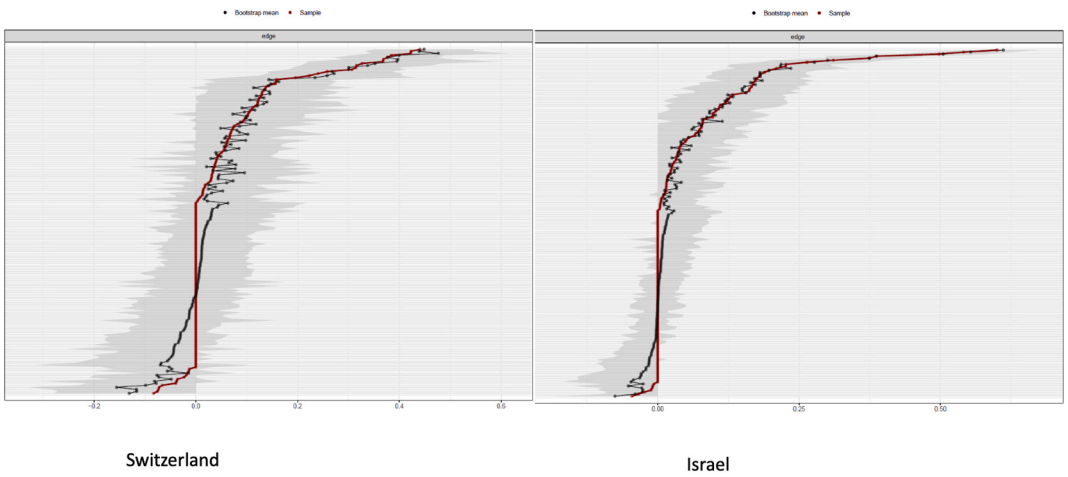

Fig. 3. Stability analysis – accuracy of edge weights. Red lines are point estimates and gray are the 95% bootstrap confidence intervals of network edges (based on partial correlation between items) for the three estimated networks. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

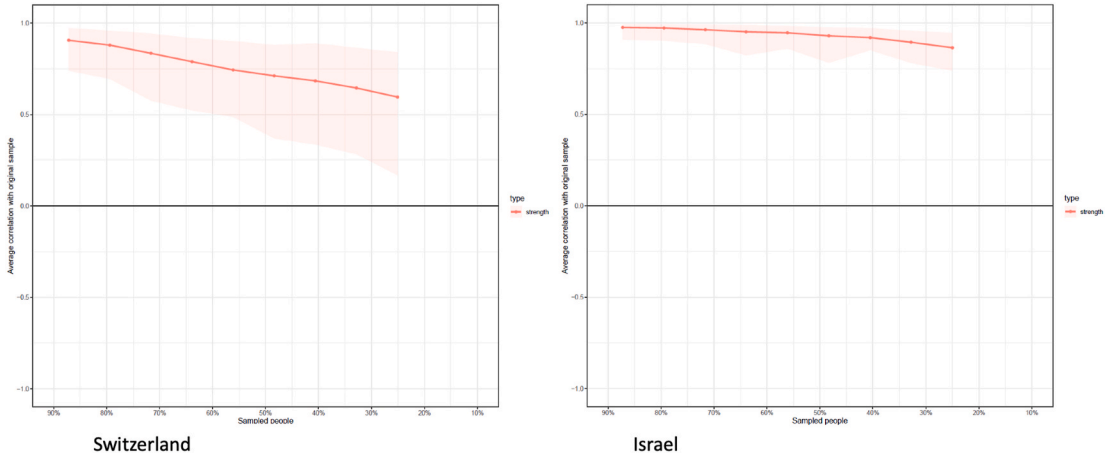

Fig. 4. Stability of centrality indices: point estimates and corresponding 95% CIs. Correlation of the original strength centrality with the strength centrality in Israel and Switzerland. The correlation after removing a substantial number of participants is high for the centrality metric strength, which indicates that this centrality estimate can be considered stable in all samples.

were validated translations of the scale, some bias may result from the different languages used in each country. Also, although the Chinese and the Swiss translation of the ASS questionnaires were previously validated, the Hebrew questionnaire was translated for this study. Combined with potential bias due to self-report, future research may benefit from including interviews to assess ASS.

4.1. Conclusions

Alongside these limitations, this study represents a unique, although unfortunate, opportunity to examine the responses to a similar acute and ongoing stressor, experienced by the majority of the worldwide population. The findings uncover that, overall, the reaction to the pandemic is similar to a certain extent, despite local, cultural, and individual differences. These findings may therefore provide an initial insight into the pattern of ASS in response to the COVID-19 pandemic and thus may pave the way for adjusting or developing necessary psychosocial interventions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contribution statement

NT contributed to the conceptualization, data curation, investigation, methodology, project administration, resources, writing- original draft and review and editing; RB contributed to the conceptualization, data curation, investigation, methodology, project administration, resources, writing-review and editing; XZ contributed to the data curation, investigation, methodology, project administration, resources; YL contributed to the conceptualization, formal analysis, methodology, visualization, writing - original draft and review and editing; HAR contributed to the data curation, investigation, methodology, project administration, resources, writing – review and editing; AM contributed to the conceptualization, resources, supervision, writing – review and editing.

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