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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Research paper

Psychological distress associated with the COVID-19 lockdown: A two-wave network analysis

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ABSTRACT

Background: Although preliminary research has evidenced negative psychological consequences of the COVID-19 pandemic among the general population, little research has been carried out examining the interplay among the broader dimensions and correlates of individual distress. Via network analysis, the current study investigated the pathways that underlie some components of psychological distress and their changes over time (during and post COVID-19-related lockdown).

Methods: 1,129 adult participants (79.1% women) completed a two-wave online survey during and after the lockdown, and reported on variables such as depression, anxiety, stress, fear of COVID, intolerance of uncertainty, emotion regulation and social support. The networks were estimated via Gaussian Graphical Models and their temporal changes were compared through the centrality measures.

Results: Depression, stress, anxiety and fear of COVID formed a spatially contiguous pattern, which remained unchanged in both the two waves. After the lockdown, the fear of COVID node reduced its strength in the network, whereas inhibitory intolerance of uncertainty and emotion suppression were associated with depression. Emotion regulation was connected to depression, but not to stress and anxiety during both waves. Perceived emotional support had few connections to the other nodes.

Limitations: Only 32.7% of participants provided complete responses for both waves.

Conclusion: The COVID-19 outbreak has had a significant psychosocial impact on adults. In the context of the network approach, depressive symptoms had the highest strength and their associations to other dimensions of individual distress may be key factors in understanding the influence of exposure to the COVID-19 outbreak on mental health.

1. Introduction

By the beginning of December 2019, the new coronavirus SARS-CoV-2 (COVID-19) pandemic was affecting physical and psychological health, with high morbidity and mortality rates worldwide (Qiu et al., 2020; Rosenbaum, 2020; Tanne et al., 2020; Wang et al., 2020). Quarantine and isolation were considered the most helpful measures in containing the infection (Brooks et al., 2020), and even though lockdown conditions varied between countries, they typically involved home confinement and restrictions on non-essential public activities (Kissler et al., 2020). Under these conditions, people are known to experience increased psychological distress (Brooks et al., 2020; Pfefferbaum and North, 2020) and negative emotions (e.g., fear, uncertainty, confusion) (Mertens et al., 2020; Schimmenti et al., 2020a).

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Preliminary reviews of the consequences of the COVID-19 pandemic on mental health revealed negative psychological effects among the general population as well as among psychiatric patients across several countries (Brown et al., 2020; Vindegaard, and Benros, 2020). Moreover, previous data from studies on epidemics such as SARS, Ebola, H1N1, indicated that little more than 50% of survivors reported high rates of emotional distress, persisting for years post infection (Bults et al., 2011; Gardner and Moallef, 2015; Jalloh et al., 2018). However, longitudinal research is scarce regarding the psychological distress consequences of the COVID-19 outbreak (Xiong et al., 2020).

To date, a number of population surveys have indicated elevated levels of psychological distress and post-traumatic stress (PTS) symptomatology during the current pandemic (Rajkumar, 2020; Vindegaard, and Benros, 2020). Some early data from China showed that 25% of the general population had experienced moderate levels of anxiety and stress symptoms in response to the COVID-19 outbreak (Qiu et al., 2020; Wang et al., 2020). The negative psychological effects of the COVID-19 pandemic on the individual's mental health were further confirmed in studies from several western countries (Newby et al., 2020; Smith et al., 2020; Tull et al., 2020; Zacher and Rudolph, 2020). However, most mental health research in the COVID-19 field has been largely descriptive and focused on frequencies of self-reported psychiatric symptoms (Duan et al., 2020; Xiong et al., 2020). Thus, there is a need for more complex approaches to data analysis in order to move this field forward by taking into account the dynamic relationships between distress symptoms over time (Jordan et al., 2020). Moreover, it was suggested that widespread COVID-19-related distress could embrace wider-ranging dimensions and correlates, such as health anxiety, emotion regulation strategies and intolerance of uncertainty (Taylor et al., 2020a). Thus, much remains to be learned about the intertwined structure of the individual's distress during the COVID-19 pandemic.

Intolerance of uncertainty (IU) has been defined as a dispositional characteristic referring to a difficulty in tolerating the negative affective state, triggered by a lack of information, as a result of which the situation is perceived as uncertain (Lauriola et al., 2016). IU and fear relating to the infection have been shown to be two relevant risk factors associated with depression, generalized anxiety, hopelessness and suicidal ideation, during the COVID-19 outbreak (Ahorsu et al., 2020; Asmundson and Taylor, 2020; Bakioğlu et al., 2020; Merterns et al., 2020; Rettie and Daniels, 2020; Satici et al., 2020).

It has also been well established that emotion regulation processes play a crucial role in reducing or heightening negative emotions and distress (Aldao et al., 2010). The emotional regulation (ER) process could be organized through cognitive reappraisal, characterized by reinterpreting situations to lessen their emotional impact; and expressive suppression, characterized by inhibiting or suppressing an emotional experience once it has been activated (Gross and John, 2003). There is initial evidence that an emotion suppression strategy can be positively linked with higher levels of psychological distress during the COVID-19 outbreak (Jiang et al., 2020; Garcia-Batista et al., 2020). However, a recent study adopting a network analysis approach (Papini et al., 2020) showed interplay between the use of reappraisal and avoidance; these two putatively opposing strategies were both associated with fear and irritability.

Finally, there is an increase in literature examining the relevance of the lack of social support following COVID-19 home confinement. Social support has been defined as the resources provided by others, such as coping assistance, or as an exchange of resources to help individuals cope with stress (Schulz, and Schwarzer, 2004). Some data from China suggest that higher social support has been a significant protective factor against psychological distress in the community and medical health professional populations during the COVID-19 outbreak (Cao et al., 2020; Ni et al., 2020; Yu et al., 2020). Furthermore, it was suggested that a higher perceived impact of COVID-19 on the individual's daily life was associated with higher perceived social support and less loneliness (Tull et al., 2020).

To sum up, although the negative psychological consequences of COVID-19 among the general population have been pre-established (Xiong et al., 2020), there has been little research identifying more specific pathways through which some psychosocial variables such as ER, IU and social support may play a key role in fostering psychological distress among population. Network analysis is a useful approach for the study of the interplay among variables and allows researchers to examine the extent to which variables belonging to the same construct are reciprocally linked and how different constructs mutually interact with each other. Recently, this approach has been widely adopted in research into mental disorders (Afzali et al., 2017b; Robinaugh et al., 2020) and is suitable for the analysis of multidimensional clinical variables, given that it does not rely on an *a priori* model of cause-effect relationships among variables (Costantini et al., 2015). The network approach to psychopathology has been especially applied to depression as a complex dynamic system (Robinaugh et al., 2020) and provided nuanced information about inter-symptom relationships. For example, Fried et al. (2016) examined what symptoms are most central to driving Major depression (MD) and found that both DSM symptoms (e.g., insomnia and sadness) and non-DSM symptoms (e.g., anxiety symptoms such as panic/phobia and anxious/tense) were among the most central symptoms. Moreover, network research on MD also highlighted that network structure and symptom endorsement rates were similar for women with different degrees of genetic and environmental risk (van Loo et al., 2018).

In the current network model, the psychological distress related to COVID-19 is seen as a network of specific characteristics (termed nodes) that dynamically interact with, and impact one another. The connections between these nodes are edges and must be statistically estimated (Jordan et al., 2020). The edges represent the association between two nodes while controlling for every other node in the network.

In the present study, we have applied a network model to provide an exploratory empirical conceptualization of dynamic networks of psychological distress symptoms with data collected on variables such as depression, anxiety, stress, fear of COVID, IU, social support and emotion regulation, in a two-wave panel study during the COVID-19 outbreak. We have aimed (1) to explore the pathways that underlie some components of psychological distress during the COVID-19-related lockdown; and (2) to compare how the psychosocial dimensions associated with psychological distress are connected during and following home-confinement due to the COVID-19 outbreak.

2. Method

2.1. Study design, participants and procedure

Respondents were recruited through online advertisements using e-mail lists and social media platforms (e.g., Facebook, Whatsapp). The recruitment window for T1 (lockdown phase) was open from April 7 to April 24, 2020, during the home-confinement measures adopted to slow the spread of the virus. The recruitment window for T2 was open between May 18 and May 31, 2020, when the social restrictions were eased (people were allowed to leave their homes, to travel, and to visit relatives and partners). One week after the end of the recruitment window, an automated reminder to take the questionnaire was sent out twice to participants who had not answered yet. The two time points (i.e. T1 and T2) were chosen to capture the potential beneficial effect of less restrictive measures in mitigating the negative psychological consequences of the COVID-19 pandemic and to observe possible changes during and after the lockdown. All respondents provided informed consent. The Bioethics Committee of the University of Palermo approved this study and the research was conducted in accordance with the Helsinki Declaration as revised 1989.

A total of 4172 participants completed the survey at T1, 719 of whom were not available to complete the survey at T2. Of the resulting 3453, 1129 (32.7%) actually provided answers at T2. For the purposes of the

current study, only participants who followed these inclusion criteria were included: (i) being above 18 years of age; (ii) spending the COVID-19 quarantine period in Italy; (iii) having provided both T1 and T2 data points. Therefore, the final sample comprises 1129 Italian participants aged from 18 to 90 years (M_{age} = 37.34; SD = 15.168) and 79.1% were women. Table 1 presents the demographic characteristics of the sample.

2.2. Measures

The Fear of COVID-19 Scale (FCV-19S; Ahorsu et al., 2020) is a self-report questionnaire to assess the level of fear associated with COVID-19; it refers to a preoccupation for contagion, physiological reaction as well as states of nervousness and anxiety associated to thinking about COVID-19 or to a search for COVID-19 related information through the media. The Italian version of the Fear of COVID-19 Scale (Soraci et al., 2020) was used in this study. The tool is composed of 7 items measured on a 5-point Likert scale, providing a global score. The higher score index indicated greater fear of COVID-19. In this study its internal consistency was α= 0.86 at both T1 and T2.

Table 1
Participants' socio-demographic characteristics (N = 1129).

	N	%
Gender		
Males	236	20.9
Females	893	79.1
Living location		
Northern Italy	339	30
Central and southern Italy	294	26
Islands	237	21
Not reported	259	23
Educational level		
Middle school	24	2.2
High school	368	32.6
Bachelor degree	249	22.1
Master degree	307	27.1
Postgraduate education	181	16
Occupation		
Unemployed	112	9.9
Employee	395	35
Employer/Freelance worker	216	19.1
Student	350	31
Retiree	56	5
Work modality during the lockdown		
Went physically to work	132	11.7
Smart-working	624	55.3
Went physically and smart-working	7	0.6
Work suspended	226	20
Fired due to lockdown	14	1.2
Other	126	11.2
Cohabitation status during the lockdown		
Alone	97	8.6
With family member/s	966	85.6
With relatives or others	66	5.8
Social distancing modality during the lockdown		
Following the social distancing rules	1115	98.8
Confined due to the infection	14	1.2
Health status		
No chronic pathology	1046	92.7
No disability	1102	97.6
Self-rated health condition		
Excellent	135	12
Very good	469	41.5
Good	406	36
Fairly good	104	9.2
Poor	15	1.1
COVID-19 positive		
Yes	7	0.6
No	1102	97.6
Suspected being infected	20	1.8
Knowing someone infected by COVID-19		
Yes	269	23.8
No	860	76.2

The Italian version of Depression Anxiety Stress Scale-21 (DASS-21; Bottesi et al., 2015; Lovibond and Lovibond, 1995) was used to assess symptoms of depression, anxiety and stress. The scale is composed of 21 items rated on a 5-point Likert scale. The instrument provides three final scores referring to the sub-scales of depression, anxiety and stress, and a total score referring to general distress. Higher scores indicated higher distress. In the present study we used the *Depression, Anxiety* and *Stress* scales, and their internal consistency values were respectively α=0.89 α=0.87 α=0.92 at T1; and α=0.90 α= 0.89 α=0.92 at T2.

The Intolerance of Uncertainty Scale – Short Form (IUS-12; Carleton et al., 2007) is 12 items on a 5-point Likert scale. The IUS-12 includes two sub-scales: *Prospective IU* referring to the desire for predictability, and *Inhibitory IU* referring to difficulty when acting in the face of uncertainty (Carleton et al., 2007). The higher score index indicated greater IU. The Italian version of IUS-12 was used (Luriola et al., 2016) and internal consistency in the present study is α=0.88 at T1, and α=0.86 at T2 for the Inhibitory IU; and α=0.82 at T1 and α=0.84 at T2 for the Prospective IU.

The Italian version of the Emotion Regulation Questionnaire (ERQ; Balzarotti et al., 2010; Gross and John, 2003) was used to assess emotion regulation strategies. The questionnaire is composed of 10 items measured on a 7-point Likert scale. The ERQ includes two scales (i.e. *Reappraisal* and *Suppression*). In the present study the internal consistency for Reappraisal is α=0.82 and α=0.85 at T1 and T2, respectively; and α=0.67 at T1 and α=0.72 at T2 for Suppression.

Perceived Emotional Social Support was measured with a four-item subscale from the *Berlin Social Support Scales* (BSSS; Schulz and Schwarzer, 2003). The items were measured on a 4-point Likert scale and referred to the degree to which respondents felt emotionally supported by close companions. Higher scores indicated higher perceived social support. The Italian version of the BSSS was previously used in clinical research (Brondino et al., 2013) and in the present study, its internal consistency was α=0.85 at T1 and α=0.89 at T2.

2.3. Data analysis

Paired t-tests with descriptive analysis were used to test differences between T1 and T2 scores. A network modeling of psychological distress was specified separately for T1 and T2. For each network, the conceptual overlap between fear of COVID, IU, regulatory strategies, social support and individual symptoms of depression, anxiety and stress was examined. The networks were estimated via Gaussian Graphical Models (GGM) through the R package *qgraph* (Epskamp et al., 2012) using a Graphical Least Absolute Shrinkage and Selection Operator (GLASSO) algorithm. GLASSO provides a more parsimonious solution (fewer connections between nodes) that reflects only the most important empirical relationships in the data (Epskamp et al., 2017). The Extended Bayesian Information Criterion (EBICglasso) was used to obtain an optimal, sparse estimate of the partial correlation matrix setting the tuning parameter (Friedman et al., 2014). GLASSO in combination with EBIC has been shown to provide sensitivity (the ratio of the number of correctly detected edges to the number of total true edges) for sparse graph and large sample size (i.e. n>250) (Epskamp and Fried, 2016). The relative importance network, including the variables that emerged as linked in the adaptive LASSO concentration network, represents the relative importance weights of node X in predicting node Y, after controlling for all the other nodes. In the networks visualized, green edges represent positive relations and red edges represent negative relations between the network nodes. Greater width of edge indicates stronger associations between the nodes. In order to qualify the importance of each node in the relative importance network, we calculated three indices of centrality: strength, *betweenness* and closeness (Costantini et al., 2015). Strength is calculated as the sum of all the directed weights accounting for a specific node, having originated from all the other nodes of the network and the total influence that a certain node exerts on all the other nodes. *Betweenness* refers to the number of times that a

specific node lies on the shortest path between two other nodes and indicates how efficiently a node connects to other nodes; whereas closeness represents the average distance from a given node to all other nodes. Together, these centrality indices indicate the variable(s) whose manipulation is most likely to influence the rest of the network, and, by representing different aspects of node centrality, the higher the levels of each index, the higher the node centrality. All the centrality indices were computed by means of the R package qgraph (Epskamp et al., 2012). To detect temporal changes, the two networks were then compared through the centrality measures (strength, closeness, and *betweenness*) (see Fig. 2). The Network Comparison Test (NCT, version 2.2.1, 2019) was then used to assess the difference between the two networks (van Borkulo et al., 2015; van Borkulo et al., 2017). NCT based on several invariance measures: network structure invariance, global strength (the summed value of all the edges in a network), invariance and single edge invariance. The current study used 1000 permutations. Finally, the reference distribution was compared with the original test statistic in order to evaluate significance.

3. Results

3.1. Preliminary analysis

The results of the present study involved 1129 participants, who provided complete response at both T1 and T2 points. However, preliminary analyses were conducted in order to compare characteristics and averages of the study variables between the responders who completed the T1 assessment and those who completed the survey at both T1 and T2. Results showed significant differences between the two groups, with very little effect for age (Cohen's $d = 0.07$), IU Inhibition ($d = 0.08$) and emotional support ($d = 0.10$). However, the two groups had similar educational and occupational conditions and did not differ regarding the other baseline psychological variables (see Supplementary Material Table S1).

Table 1 showed sample characteristics regarding distributions of gender, living location and conditions, educational level, occupation, work modality and Covid-19 related info. Paired *t*-test results are shown in Table 2. Depression and fear of COVID showed a significant decrease between T1 and T2, while the IU – inhibitory scale showed a significant increase. All other variables did not present significant differences at T2 when compared to T1. Pearson's correlations among variables are reported in Supplementary Material Table S2.

3.2. Network analysis

3.2.1. Network structure at T1 and T2

The regularized partial correlation network returned by the graphical LASSO, representing the estimated network structure of psychological distress during and post lockdown, is shown in Fig. 1. At T1, depression, stress, anxiety and fear of COVID formed spatially contiguous patterns, with densely interconnected nodes; in the psychological distress domain, the strongest edge was found between feeling of depression and stress (0.53), followed by connections of anxiety with stress (0.35) and fear of COVID (0.30). The results showed a more central role for depression than fear of COVID. Indeed, at T1, depression presented the highest strength centrality index ($M = 1.39$), followed by stress ($M = 1.18$), EQR suppression scale ($M = 0.93$), anxiety ($M = 0.88$), prospective IU ($M = 0.85$), EQR reappraisal ($M = 0.82$), inhibitory IU ($M = 0.80$), fear of COVID ($M = 0.72$) and emotional support with the lowest strength index ($M = 0.29$). Depression shows the greatest closeness and *betweenness* (see Fig. 2), followed by stress, prospective IU and suppression.

Moreover, results show that, at T1, fear of COVID was also directly and positively associated with stress, IU and suppression (range 0.04 to 0.13), and negatively with depression (0.10); whereas depression was positively associated with inhibitory IU, anxiety and suppression (range 0.12 to 0.20), and negatively with reappraisal (0.16) and support (0.08). Interestingly, we found a negative association between reappraisal and both IU scales (0.06 and 0.09, respectively), and a positive association between suppression and prospective IU (0.14).

After the lockdown (T2), the central aspects of the network remained unchanged. Depression, stress, anxiety and fear of COVID maintained their spatially contiguous patterns, with densely interconnected nodes, confirming the strongest edge between feelings of depression and stress (0.55); followed by connections between stress and anxiety (0.34) and between anxiety and fear of COVID (0.31). At T2, depression ($M = 1.25$) still shows the highest strength centrality, although now followed by stress ($M = 1.02$), inhibitory IU ($M = 0.88$), suppression ($M = 0.83$) and anxiety ($M = 0.81$). Moreover, depression and stress still show the greatest closeness and *betweenness*. Reappraisal ($M = 0.76$) shows a greater strength index when compared to prospective IU ($M = 0.70$) and fear of COVID ($M = 0.46$), whereas support ($M = 0.35$) shows the lowest strength indices.

Considering the preponderance of women in the sample a *post-hoc* analysis was conducted to estimate the effect of gender on the study's findings. NCT results suggested that both the structure of the network as a whole (M_{T1}=0.03, M_{T2}=0.03, p_s=0.99) and the strength of connections within the networks (S_{T1}=0.22, $p = 0.65$; S_{T2}=0.13, p_s=0.68) were not significantly different when the network analysis conducted only on women was compared with the analysis which considered the overall sample.

3.2.2. Transition from T1 to T2

Visual inspection of networks at T1 and T2 suggests potentially meaningful changes in the network structure. The NCT was used to identify temporal differences in the overall structure of networks and to compare the cumulative strength of the edges within the network. The NCT indicated that network invariance was not different between the two data points ($M = 0.08$, $p = 0.27$), whereas the global strength resulted significantly greater in T1 than in T2 (global strength = 4.34 and 3.67, respectively), suggesting that although the structure of the network as a whole remained similar, the strength of connections within the networks changed significantly ($S = 0.67$, $p = 0.04$), highlighting less connectivity among variables. Visual inspection revealed that many edges, which are present at T1, were then absent at T2. Specifically, fear of COVID became less influential, as evidenced by its reduced centrality ($p = 0.01$) and absence of edges with stress, suppression and depression at T2. At the same time, the link between anxiety and inhibitory IU, as well as between stress and suppression, was no longer present at T2. As seen in Fig. 2, centrality indices at T2 also showed greater strength and *betweenness* for inhibitory IU, whereas prospective IU showed less closeness and *betweeneess* than T1. Regularized associations confirmed these results showing changed edges between ERQ and IU subscales that

Table 2
Descriptive and T1-T2 mean differences for the study variables included in the network ($N = 1129$).

	T1 Mean (SD)	T2 Mean (SD)	Mean Difference	t-value	*p*-value
suppr	3.98 (0.76)	4.02 (0.75)	−0.04	−1.81	.07
reappr	5.13 (1.12)	5.15 (1.14)	−0.02	−0.73	.47
iuin	12.62 (5.02)	13.11 (5.16)	−0.50	−4.16	< 0.001
iupr	23.06 (5.73)	23.29 (5.85)	−0.21	−1.81	.07
fearCvd	14.96 (5.53)	14.04 (5.43)	0.91	7.50	< 0.001
stress	8.91 (5.66)	8.82 (5.86)	0.08	0.54	.59
dep	8.55 (7.02)	8.16 (7.25)	0.38	2.17	.03
anx	3.60 (4.40)	3.46 (4.51)	0.13	1.24	.21
supEm	6.01 (1.12)	5.98 (1.16)	0.02	0.65	.52

Note: Paired t-test; Two-tailed; suppr: ERQ-Suppression sub-scale; reappr: ERQ-Reappraisal sub-scale; iuin: IU Scale-Inhibitory sub-scale; iupr: IU Scale-Prospective sub-scale; fearCvd: Fear of COVID-19 Scale; stress: DASS-Stress sub-scale; dep: DASS-Depression sub-scale; anx: DASS-Anxiety sub-scale; supEm: BSSS-Perceived emotional support.

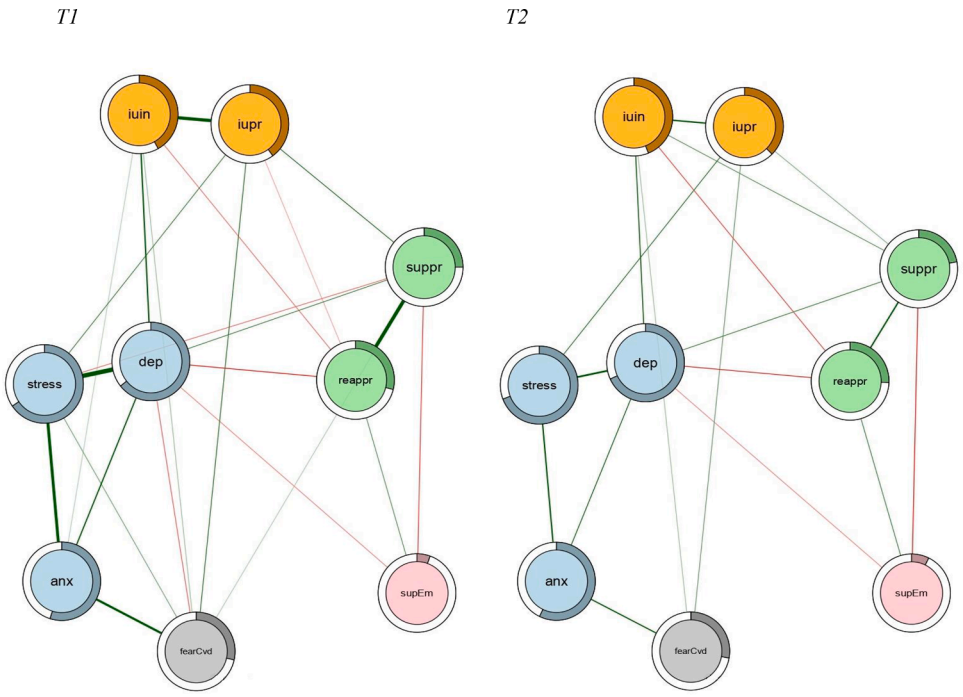

Fig. 1. Network structure at T1 and T2.
Note: suppr: ERQ-Suppression sub-scale; reappr: ERQ-Reappraisal sub-scale; iuin: IU Scale-Inhibitory sub-scale; iupr: IU Scale-Prospective sub-scale; fearCvd: Fear of COVID-19 Scale; stress: DASS-Stress sub-scale; dep: DASS-Depression sub-scale; anx: DASS-Anxiety sub-scale; supEm: BSSS-Perceived emotional support; rings around nodes convey variance in a given variable with shadowed parts displaying that part of the variance in each node that is explained by nodes that connect with it.

plotted a quite new configuration. In particular, inhibitory IU now resulted positively associated with suppression, whereas prospective IU was no longer associated with reappraisal. Finally, network stability was assessed through case-dropping bootstrapping, measured with the central stability coefficient (CS; maximum drop proportion to retain correlation of 0.7 in at least 95% of the sample) underlying a highly satisfactory CS for the edges (CS = 0.75) as well as for the strength centrality index (CS = 0.67).

4. Discussion

To our knowledge, this is the first study that has adopted a network approach to examine the associations between psychological distress, fear of COVID, intolerance of uncertainty, emotion regulation strategies, and social emotional support in a two-wave survey during the COVID-19 pandemic. Our results show that the nodes belonging to psychosocial distress, emotion regulation, and intolerance of uncertainty were generally associated and close to each other at T1 (during the lockdown phase) as well as at T2 (after the lockdown). Moreover, depression, stress, anxiety and fear of COVID formed a spatially contiguous pattern, which remained unchanged in both the two waves. The depression and stress nodes play a key role in the network both at T1 and T2; in line with previous studies (Satici et al., 2020; Fitzpatrick et al., 2020), depression and stress nodes show high centrality and strong connections to the other nodes, and high *betweenness* and closeness.

Although previous surveys reported a moderate prevalence of depressive and anxiety symptoms during the COVID-19 outbreak (Elhai et al., 2020; Qiu et al., 2020; Tull et al., 2020; Zhang et al., 2020), our study adds the central role of depression, which can have considerable impact on other symptoms, given its high strength centrality and high connectedness with other dimensions of psychosocial distress. Furthermore, the centrality of depression at both T1 and T2 can be viewed in the context of research showing that depression is associated with suppression, inhibition of uncertainty (Inhibitory IU) and low social support during the COVID-19 pandemic (Asmundson and Taylor, 2020; Jiang et al., 2020).

The results of the present study are in line with previous evidence indicating that IU is associated with mental health difficulties during the COVID-19 outbreak (Rettie and Daniels, 2020; Taylor et al., 2020a), as shown by the links between Inhibitory IU (i.e. referring to difficulty in acting in the face of uncertainty) and higher levels of depression, anxiety and fear of COVID. Our findings add to literature the higher centrality of Inhibitory IU after the lockdown phase, as reflected by its increased strength and *betweenness* indices at T2. Thus, the individual's negative emotions and behavior when experiencing uncertainty can have an impact on depression and fear of COVID even after the lockdown, possibly due to *not knowing* when the threat of COVID-19 will remit.

Consistent to expectations, participants reported lower levels of depression, fear of COVID and Inhibitory IU after the lockdown phase. However, the changes in network structure between T1 and T2 depict a more fine-grained picture of the characteristics of the individual's distress during the COVID-19 pandemic. Indeed, while no significant changes were observed regarding the strength of symptom associations, interesting changes in the spatial connectivity and structure of the psychological distress network are worth noting. After the lockdown, the fear of the COVID node reduced its strength in the network (i.e. its low influence on other nodes in the network), and showed no lasting association with stress, depression and suppression. These results suggest that although the fear of COVID was a relevant dimension of distress during the COVID-19 lockdown (Mertens et al., 2020), it does not play a key role in the network structure when the home-confinement restrictions have been eased. Moreover, its strength centrality index further decreased at T2, only being associated with anxiety and both facets of IU. This result suggests that with lower social-distancing measures and a more effective containment of the spread of the virus, the influence of fear of COVID may account for a different pathway of interconnections, which would highlight a specific pattern of COVID-related anxiety symptomatology (Asmundson and Taylor, 2020; Fernàndez et al., 2020; Schimmenti et al., 2020a; Taylor, 2019) powered by feelings of fear and uncertainty.

Moreover, the results of the transition from T1 to T2 highlighted that COVID −19- related depressive symptomatology is a complex emotional dimension, involving various interlinked aspects that may play a crucial role in buffering or increasing mental suffering during the pandemic. At T2 the depression node appears to be more clearly linked with other specific nodes representing potential vulnerabilities and protective

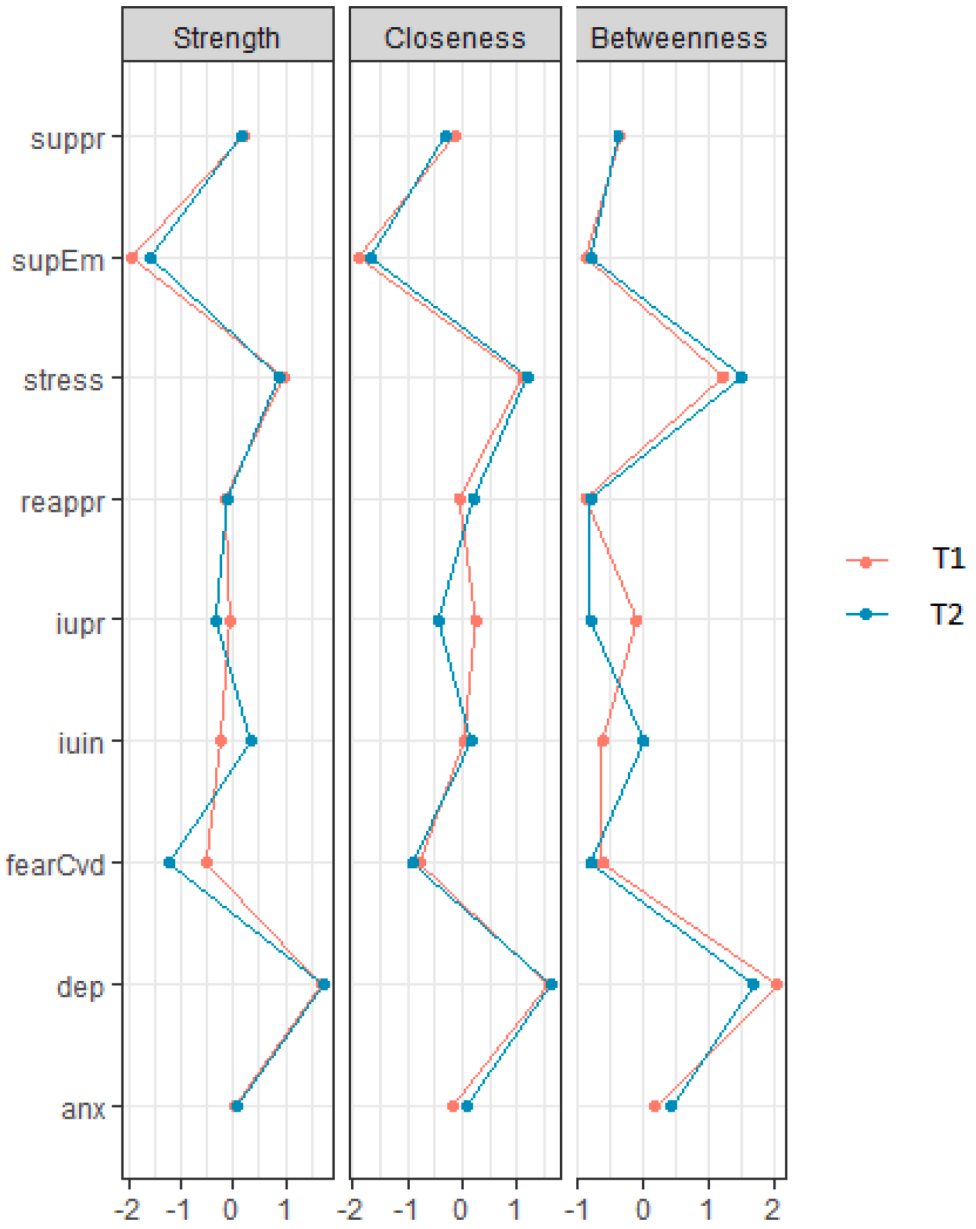

Fig. 2. Centrality indices at T1 and T2.
Note: *suppr: ERQ-Suppression sub-scale; reappr: ERQ-Reappraisal sub-scale; iuin: IU Scale-Inhibitory sub-scale; iupr: IU Scale-Prospective sub-scale; fearCvd: Fear of COVID-19 Scale; stress: DASS-Stress sub-scale; dep: DASS-Depression sub-scale; anx: DASS-Anxiety sub-scale; supEm: BSSS-Perceived emotional support.*

factors. More specifically, the results suggest potential pathways through which depression after the lockdown could be triggered by Inhibitory IU and suppression and, on the other hand, may be weakened by emotional social support and cognitive reappraisal. Although no causal direction can be drawn from this study, these results are in line with those which have provided evidence regarding the link between depression, IU, social support, and both adaptive and maladaptive emotional strategies (Dryman, and Heimberg, 2018; Gariepy et al., 2016; Gentes, and Ruscio, 2011).

Interestingly, at T2, the two facets of IU showed two distinct edges with Fear of COVID and with both reappraisal and suppression, suggesting a vicious self-reinforcing circle in which IU might increase ineffective emotional strategies and fear response, which, in turn, may increase both the emotional and behavioral difficulty in acting in the face of uncertainty. This view is in line with a recent study by Ouellet et al. (2019), which evidenced the fact that IU is associated with the emergence of negative cognitive and emotional reactions, not only in relation to problems, but also in relation to emotions experienced. Given that the core of IU is an inherent and dispositional fear of the unknown, it is likely that, in the context of the COVID-19 pandemic, individuals with a low tolerance of uncertainty could feel overwhelmed and unable to effectively manage negative and threatening negative emotions.

It is worth noting that ER was connected to depression, but not to stress and anxiety both at T1 and T2. These results seem consistent with research on emotion regulation and mood states, confirming that individuals with depression are unable to regulate their emotions through cognitive reappraisal and may attempt to suppress their outward emotional expression, worsening depression (Dryman and Heimberg, 2018). However, our findings are in contrast to those which have implicated maladaptive emotion regulation in anxiety symptoms. We could speculate that the relation between emotion regulation and some anxiety disorder symptoms is not necessarily direct (Cisler and Olatunji, 2012) and further research is needed to test mediational models for considering indirect effects among these variables.

Perceived emotional support had few connections to the other nodes, as reflected by its low *betweenness* and closeness. In particular, emotional support showed no direct connections with stress, anxiety, fear of COVID nodes, nor with intolerance of uncertainty. However, a low level of social support was linked to heightened feelings of depression and suppression both at T1 and T2. Although there have been concerns that social distancing would lead to lower social support, recent studies have shown that people have perceived more support from others during the COVID-19 pandemic (Luchetti et al., 2020; Ruggieri et al., 2020; Tull et al., 2020). Our results suggest the relative importance of low emotional support perceived in the context of the psychological distress network, which could reflect the individual's feelings of being part of community-wide efforts to slow the spread of the infection.

4.1. Strengths and limitations

The current study has several strengths that are worth noting. Firstly, it is the first network two-wave analysis on COVID-19-related psychological distress, which may add evidence to the multitude of previous cross-sectional surveys among population-samples. Despite the growing evidence for the prevalence of emotional distress during pandemics, no previous studies in this field had aimed to detect how specific pathways of psychosocial variables may play a role in raising and maintaining, from a network perspective, psychological distress among the general public. Secondly, we used a large national adult sample, which allowed for sufficient power to detect relationships between variables. Thirdly, we adopted a two-wave perspective that allowed us to note that psychological distress occurs in the immediate aftermath and then persists throughout social distancing measures. As suggested by Galea et al. (2020), this clearly indicates the urge to advance our understanding of how to mitigate the psychological consequences of COVID-19 through prevention interventions and how to deliver appropriate mental health care at a population level.

Besides these strengths, several factors limit the study. Firstly, although this study is highly informative regarding the network connectivity and structure of psychological distress and on how it changed during the lockdown and post-lockdown restrictive measures, inferences drawn from this study should acknowledge that network analyses do not define causal association. Secondly, the study did not use a random population sample, and therefore the parameters of interest may vary from one sample to another. Moreover, only 32.7% of participants completed the follow-up survey. Further studies on more representative samples and data collected across multiple time-points are needed to confirm our findings. Thirdly, we might have undervalued the importance of some constructs –e.g., resilience or rumination - which have been proven to play an important role in modeling psychological distress during pandemics (Satici et al., 2020; Veer et al., 2020). Nevertheless, the invariance of network structure, edge strength, and global strength between the two networks also indicates that this study grasps relevant variables in the context of the current pandemics and its impact on mental health. Further limitations of the study include the short time-lag between the two data points. Although we monitored the levels of psychological distress both during the lockdown phase in Italy (T1) and in the subsequent time (T2) when the lockdown restrictions were eased, the short time gap between T1 and T2 could have prevented us from monitoring fluctuations in the individual's distress, something which can take longer to change. Lastly, some relevant COVID-19 measures offering a multidimensional perspective of pandemic-related fear and anxiety were published after the beginning of the survey (e.g., Schimmenti et al., 2020b; Taylor et al., 2020b). We believe that their contribution to future research can lead to more nuanced insights regarding how fear and anxiety about the infection may affect people's psychological well-being during pandemics.

5. Conclusion

The present study was the first to investigate the network structure of psychological distress in a national community sample during the COVID-19 pandemic. The network approach provides useful insights into understanding how initial emotional distress responses evolve during and after home-confinement due to the COVID-19 outbreak. The results suggest that depressive symptoms and their associations to other dimensions of individual distress are a key factor in understanding the influence of outbreak exposure on mental health. The high strength centrality and high connectedness of depression suggest that early and focused interventions are needed to reduce psychological suffering. Furthermore, in the context of the network approach, not only should central symptoms be identified and addressed, but also edges and pathways in which central symptoms are entrenched. Our findings indicate that disentangling the role of protective and risk factors may expand our understanding of processes operating in COVID-19-related psychological distress, providing important indications for treatment and prevention. Along these lines, results suggest that interventions focusing on enhancing social support and effective emotional coping strategies are likely to minimize the impact of COVID-related depressive symptomatology.

Contributors

Authors MDB, SG, and GLC designed the study, wrote the protocol and managed the literature searches. Authors SG and EM undertook the statistical analysis, and authors MDB and GLC wrote the first draft of the manuscript. SG, EM, MFF, GE, OCGG, GL, CG, CM, CP, SS critically reviewed the draft of the manuscript and contributed to the interpretation of results and to the subsequent redrafting of the manuscript. All authors contributed to and have approved the final manuscript.

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Declaration of Competing Interest

None.

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Supplementary materials

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