This is a preprint awaiting peer review

The network structure of stress-related states, depression, and anxiety symptoms during the COVID-19 lockdown

Asle Hoffart^{1,2}

Sverre Urnes Johnson^{2,1}

Omid V. Ebrahimi^{2,1}

¹Research Institute, Modum Bad Psychiatric Hospital, Vikersund, Norway

²Department of Psychology, University of Oslo, Oslo, Norway

Citation:

Hoffart, A., Johnson, S. U., & Ebrahimi, O. V. (2020, December 22). The network structure of stress-related states, depression, and anxiety symptoms during the COVID-19 lockdown.

doi: <https://doi.org/10.31234/osf.io/xa8qk>. Retrieved from <https://psyarxiv.com/xa8qk>.

Author for correspondence

Asle Hoffart,

E-mail: asle.hoffart@modum-bad.no

Abstract

Background. The coronavirus (COVID-19) pandemic and the social distancing protocols used to impede the spread of the virus may have severe mental health consequences. The purpose of this study was to investigate the network of components of pandemic-related negative psychological states (i.e., fear of infection, financial worries, loneliness) and symptoms of major depressive disorder (MDD) and generalized anxiety disorder (GAD).

Methods. Data from 10,061 Norwegian adults recruited through an online survey during a period of strict social distancing protocols were analyzed employing a cross-sectional Gaussian Graphical Model.

Results. Of the infection fears, fear of being infected, fear of dying from the coronavirus and fear of significant others dying from it had notable connections to the GAD symptoms anxiety and/or fear of awful events. The financial worry component worry about personal economy was connected to the MDD symptom sleep problems and to the GAD symptom generalized worry. Each of the loneliness components was connected to a specific MDD symptom. Anhedonia, depressed mood and worthlessness had the highest strength centrality among the MDD symptoms; generalized worry, uncontrollability of worry, and trouble relaxing among the GAD symptoms; fear of dying from the virus among the fear of infection components; and feeling isolated among the loneliness components. A community analysis identified separate clusters for MDD and GAD as well as a cluster cutting across the two disorders.

Conclusions. Particular components of the pandemic-related distressing states of fear of infection and loneliness seem to be associated with specific symptoms of MDD and GAD.

Key words:

COVID-19; fear of infection; financial worry; loneliness; major depressive disorder symptoms; generalized anxiety disorder symptoms; cross-sectional network analysis

Introduction

The coronavirus (COVID-19) pandemic and the social distancing protocols used to impede the spread of the virus may have severe mental health consequences (Holmes *et al.*, 2020). In particular, depression and anxiety are likely to increase, as documented during previous pandemics (Brooks *et al.*, 2020) and the present pandemic (Ebrahimi *et al.*, 2020; Salari *et al.*, 2020). In the present study, a network approach was adopted to enhance understanding of how the COVID-19 pandemic influences symptoms of depression and anxiety. In the traditional psychiatric disease model of mental disorders, life events are assumed to activate a latent underlying pathological process, which, in turn, causes observable symptoms (Kendler *et al.*, 2011; McNally *et al.*, 2015). According to the network perspective of psychopathology, by contrast, mental disorders arise from the direct causal interactions of symptoms and external events (Borsboom, 2017). Thus, stressful life events may activate one or two symptoms, which, in turn, elicit more symptoms. Symptoms are thought to have different causal roles and centrality indices are used to estimate their overall importance in the network of events and symptoms (Opsahl *et al.*, 2010). Central symptoms may be particularly useful targets for intervention (Cramer *et al.*, 2010).

Three kinds of stressors related to the pandemic and society's handling of it are likely to affect individuals and potentially elicit certain distressing psychological states in them. First, the threat of infection posed by the virus may elicit a fear that significant others may become infected and die, fear of infecting others, fear of oneself being infected, and fear of dying from the virus. Thus, a fear that something awful might happen may be implied, a clinical feature of generalized anxiety disorder (GAD; Spitzer *et al.*, 2006). In addition, the infection fears are likely to elicit nervousness and anxiety, also a feature of GAD (American Psychiatric Association, 2013). Second, the work-related and economic consequences of the

social distancing measures, such as shutdown of enterprises and laying off and dismissal of employees, may increase individuals' worry about their personal economy and job. This state implies worry about future adversities, a hallmark symptom of GAD (American Psychiatric Association, 2013). Moreover, individuals tend to blame themselves for work- and financial problems (Shamir, 1986), leading to rumination and low self-esteem, which in severe degrees is a clinical feature of major depressive disorder (MDD; American Psychiatric Association, 2013). Third, the social distancing measures involve social isolation and loss of availability of direct social contacts. These circumstances promote the experience of loneliness, with its many components, such as missing companionship, feeling left out and feeling isolated. Due to increased frictions and conflicts within households, people may also feel a lack of companionship with others that are still around. Loneliness have proved to be associated with increased risk of depression and anxiety (Yuanguas *et al.*, 2011). On the level of symptoms, loneliness has been found to be related to depressed mood through sadness (Fried *et al.*, 2015). Thus, pandemic-related stressors may elicit distressing states, which, in turn, may precipitate MDD and GAD symptoms in some people and aggravate symptomatology in those already suffering from these symptoms. In a network approach, the relationships among the specific components of these states and specific symptoms can be estimated concurrently in one analysis.

MDD and GAD often occur together. The literature has highlighted GAD as the disorder with the highest rate of co-occurrence with MDD (Kessler *et al.*, 2005), suggesting that these disorders may include symptoms that may easily activate and influence each other. By moving the level of causality to that of observable symptoms rather than unobservable latent entities, the network perspective easily accommodates this possibility by pointing to potential causal influences between symptoms across the two disorders as well as overlapping

clinical features and symptoms (e.g., concentration difficulties, sleep disturbances, fatigue; Cramer *et al.*, 2010).

Previous network research on MDD has identified depressed mood, anhedonia, loss of energy, and low self-esteem as the symptoms with the highest strength centrality. Cramer *et al.* (2010) identified anhedonia and depressed mood as those with highest strength, Osborn *et al.* (2020) depressed mood and worthlessness, Briganti *et al.* (2020) depressed mood, Fried *et al.* (2016) anhedonia and loss of energy, and Hakulinen *et al.* (2020) anhedonia and worthlessness. Among GAD symptoms, Osborn *et al.* (2020) found generalized worry and uncontrollability of worry as the symptoms with the highest strength centrality.

Related to COVID-19 pandemic, Wang *et al.* (2020) investigated the MDD and GAD networks among Chinese adults during the COVID-19 outbreak and after peak. At outbreak, the MDD symptoms depressed mood, loss of energy, psychomotor problems and suicidality and the GAD symptoms generalized worry, trouble relaxing and restlessness showed high strength centrality.

In a previous paper, the prevalence of clinically significant levels of symptoms of MDD and GAD in sample of adult Norwegians during the implementation of strict social distancing protocols has been reported (Ebrahimi *et al.*, 2020). This investigation revealed that 30.8% exceeded the cut-off of for clinically significant levels of MDD symptoms, and 27.6% the cut-off of for clinically significant GAD symptoms, respectively, during the pandemic, estimates which have since been replicated in international meta-analyses (e.g., Salari *et al.*, 2020). In another paper, the total score on a measure of loneliness was found to be related to worry about job and personal economy and MDD and GAD total symptom scores (Hoffart *et al.*, 2020). The purpose of this study was to investigate the network of components of pandemic-related negative psychological states and symptoms of MDD and GAD in the same sample, analyzing the items of the measures used in the previous studies.

More specifically, the present study examined the relationships of these components to particular symptoms and to each other, in addition to the centrality of these components and symptoms.

Methods

Study design and participants

A cross-sectional design was implemented in an epidemiological survey of the general adult Norwegian population during the COVID-19 pandemic. Eligible participants were all individuals of 18 years and above, were living in Norway and thus experiencing identical social distancing protocols, who provided informed consent to participate in the study. The implemented protocols included not leaving home unless essential, home isolation if infected, quarantine after exposure to possible infection, closure of kindergartens, schools, universities, workplaces and other public spaces, restrictions on traveling, and prohibitions of social gatherings and public events. These protocols were implemented in Norway on March 12th 2020. The period of data collection lasted seven days between March 31st 2020 and April 7th 2020. The implemented social distancing protocols were held constant for approximately three weeks prior to data collection and during the data collection period. Additionally, no new information was given by the government during this period with regard to changes of the protocols, keeping expectation effects constant.

Ethical approval of the study was granted by the Regional Committee for Medical and Health Research Ethics (reference: 125510) and the Norwegian Centre for Research Data (reference numbers: 802810), where the study protocol and analysis plan was approved prior to data collection. The study is part of the Norwegian COVID-19 Mental Health and Adherence Project (Ebrahimi *et al.*, 2020).

Procedure

Due to the sudden onset of the pandemic and the initial infection guidelines as well as the time-sensitive research aim of measuring mental health during a period with strict, stable and nationally identical social distancing measures, we could not disseminate the survey through conventional methods such as access to registry data. To approach the desired standard of giving the adult Norwegian population an equal opportunity to participate, the survey was disseminated through a Facebook Business algorithm, with imputed parameters encompassing a population of 3.6 million adults and in total reaching 174,885 of these individuals. This algorithm proportionately samples from each region compared to their relative size. We also disseminated information through national television, national, regional and local radio stations and newspapers, as well as local and regional media and social media sources. The dissemination procedure is described in more detail elsewhere (Ebrahimi *et al.*, 2020).

Measures

The participants were asked to report demographic variables. In addition, stressor-related questions about suspicions of being infected, the time staying home and reasons for this, and whether one had been laid off from or lost one's job due to COVID-19 were included.

For the measures of network nodes, the participants were asked to consider the last two weeks. The Patient Health Questionnaire-9 (PHQ-9; Kroenke *et al.*, 2001) consists of nine items covering the DSM-IV criteria for major depression scored on a 4-point 0 (*not at all*) to 3 (*almost every day*) scale. The Generalized Anxiety Disorder-7 (GAD-7; Spitzer *et al.*, 2006) consists of seven items covering the DSM-IV criteria for GAD scored on a 4-point 0 (*not at all*) to 3 (*almost every day*) scale.

Due to the lack of available instruments for measuring fear of infection of the specific virus and financial worries as a result of the pandemic at the time, we developed specific questions for this purpose. Thus, fear of infection was measured by the following four items: “I fear that a significant other may die from the coronavirus”, “I fear that I may infect others”, “I fear that I am infected with the coronavirus”, and “I fear that I will die from the coronavirus”. These items are rated on a scale ranging from 0 (*never*) to 3 (*almost every day*). Financial worry was measured by the items: “I worry that I will lose my job” and “I worry about my personal economy”, using a scale ranging from 0 (*never*) to 3 (*almost every day*) scale.

The UCLA Loneliness Scale-8 (ULS-8; Hays & DiMatteo, 1987) measures the frequency of components of loneliness, using a 1 (*never*), 2 (*rarely*), 3 (*sometimes*) and 4 (*often*) scale. One of the eight items refers to a personality style (“I am an outgoing person”) and was excluded. Some of the remaining seven items have pairwise overlapping content. Of these, the ones with the highest scores in the original psychometric study were selected (Hays & DiMatteo, 1987). Thus, the following four items were utilized: “I lack companionship”, “I feel left out”, “I feel isolated from others” and “People are around me but not with me”.

Statistical analyses

All statistical analyses were conducted in R (version 4.0.2; R Core Team, 2019). The scale of the ULS-8 items were transformed from a 1 to 4 to a 0 to 3 scale to be comparable in mean scores to the other items analyzed. The items are measured on an ordinal scale and many of the distributions were skewed. Consequently, Spearman correlations were used to estimate the network. Given the large number of participants in the present study, an unregularized method referred to as the Graphical Gaussian Model ModSelect Algorithm (i.e., ggmModSelect) in the R-package *qgraph* (Epskamp *et al.*, 2012) was used in line with recent recommendations

(Williams & Rast, 2018). In this procedure (see online supplementary material for R code), the graphical least absolute shrinkage and selection operator (gLASSO) is used to estimate the structure of 100 regularized network models ranging from sparse to dense. The algorithm continues to fit an unregularized network for each of these models using gLASSO without regularization, but with zeroes constrained according to the network structure. Within this model selection technique, parameters are obtained through maximum likelihood estimation, yielding unbiased estimates of parameters. Consequently, gLASSO is used to obtain the structure of the network, while maximum likelihood estimation is used to obtain the parameters. The Bayes Information Criterion (BIC) for each newly estimated model is computed iteratively, and the model with the lowest BIC is selected. In other words, all possible models in which one edge changed (i.e., was absent or present) is tested. The final model is attained when no edge can be removed or added to optimize the BIC.

The Fruchterman-Reingold algorithm was used to visualize the network, which pulls nodes with the highest centrality towards the center of the network, while nodes that are less central nodes are placed toward the periphery (Fruchterman & Reingold, 1991). Of note, the aim of this algorithm is to minimize the number of crossing edges and to position nodes so that edges have approximately equal length. The spatial arrangement does not reflect the relationships between the variables.

Three common node centrality indices (Opsahl *et al.*, 2010) were estimated using the centrality plot function of the *qgraph* package. Node strength is the direct connection of a node to the network, calculated as the sum of the edge weights that connect that node to the other nodes in the network. Closeness is the indirect connection of a node to the network, calculated as the sum of the inverse of all shortest path lengths between one node and all others. Betweenness is the indirect connection of a node to the network, calculated as the number of times a node lies on the shortest path connecting two other nodes in the network.

Strength centrality was emphasized, as it is proportional to the extent to which a given node uniquely explains variance in nodes to which it is connected. The centrality indices were standardized to z -scores.

The accuracy of edge weights was assessed by nonparametric bootstrapping (1000 iterations) 95% confidence intervals (CIs) using the R-package *bootnet* (Epskamp *et al.*, 2018). The stability of node strength was assessed using case-dropping subset *bootstrap* (1000 iterations). In this procedure, the correlation between the original centrality indices and the centrality indices as obtained from smaller subsets, with up to 75% of participants dropped, is assessed. To quantify the stability of the indices, correlation stability coefficients (CS-coefficients) were calculated. A CS-coefficient indicates the maximum proportion of cases that can be dropped to retain, with 95% certainty, a correlation with the original centrality indices of 0.70 or higher. The CS-coefficient should preferably be 0.50 or higher (Epskamp *et al.*, 2018). Finally, to investigate the community structure of the overall network, the spinglass algorithm (Reichardt & Bornholdt, 2006) from the *igraph* package (Csardi & Nepusz, 2006) was used. This algorithm allows items to solely be part of one community. There were no data missing in our set because the online survey system comprised of mandatory fields of response.

Results

Characteristics of participants and representativity

The number of participants was 10,061. Social distancing protocols were employed in Norway from March 12, 2020, and the data collection in this study was conducted between March 31, 2020 and April 7, 2020. Consequently, at the time of measurement, the duration that the respondents had experienced the implementation of the protocols ranged from 19 to 26 days. In terms of representation of the Norwegian population, a larger proportion of

females (7,851, 78.0%) than males (2,184, 21.7%) responded. The sample was also not representative of the Norwegian population in terms of educational level as 5,644 (56.1%) had completed a university degree, compared to about 34.1% in the population (Statistics Norway, 2019). The sample was relatively representative on the other demographic variables. The age of the participants ranged between 18 and 86 with a mean age of 36.0 years (S.D. = 13.5), 4,751 (47%) were married or in a civil union, 8,140 (81%) were currently employed, 574 (6%) were non-natives, 4,253 (42%) had children. The proportion having a psychiatric diagnosis was 1,721 (17.1%) of 10,061, reflecting the lower end of the known rate of psychiatric disorders in the adult population of Norway which is between 16.7 to 25.0% (Norwegian Institute of Mental Health, 2016).

Relevant to the stressors studied here, 3,583 (35.6%) of the 10,061 participants reported suspecting being infected by COVID-19 during the two-week period. The majority (n=7,952, 79.0%) of the sample had adhered to the social distancing protocols and stayed home most of the days (at least 10) of the last two weeks, 1,429 (14.2%) had been in home isolation or quarantine because of potential or proved infection, 693 (6.9%) has stayed home because of closure of own enterprise and 854 (8.5%) had been assigned to home office by their employer. The number partly or fully laid off from work because of COVID-19 was 1,289 (12.8%) and 132 (1.3%) had lost their job due to the COVID-19.

Descriptive statistics for the network variables

The descriptive statistics of the PHQ-9, GAD-7 and state items are reported in Table 1, showing that the PHQ items 8 and 9 about psychomotor problems (retardation or agitation) and suicidal ideation, the GAD item 5 about restlessness, and the fear of dying from the corona virus had low levels. The PHQ item 4 about loss of energy, the fear of significant others dying from the virus, and the 4 loneliness items had the numerically highest levels.

Suicidal ideation and the fear of oneself dying items had the numerically lowest standard deviations and their distributions were skewed.

Estimated network

The partial correlation network, based on Spearman rank order correlations, is visualized in Figure 1. As mentioned above, the spatial relations cannot be meaningfully interpreted because a force-directed algorithm was used. There were 137 significant ($p < 0.05$) connections. This large number is related to the large power of the study and here only those that have an edge weight greater than 0.05 will be noted. The fear of infection components had notable connections solely to the GAD symptoms. Fear of dying from the coronavirus and fear of significant others dying from the virus had marked connections to fear of awful events (0.22 and 0.19, respectively). Fear of being infected and fear of dying were connected to anxiety (0.07 and 0.06, respectively). Of the financial worries, worry about personal economy had notable connections to sleep problems (0.06) and to generalized worry (0.07). Each of the loneliness components was connected to a specific MDD symptom: missing companionship to anhedonia (0.08), feeling left out was connected to worthlessness (0.09), feeling isolated to depressed mood (0.07), and experiencing that people are around but not with one to suicidal ideation (0.06).

Within constructs, the strongest connections appeared between the MDD symptoms loss of energy and sleep problems, loss of energy and anhedonia, and anhedonia and depressed mood. Among the GAD symptoms, the strongest connections appeared between uncontrollable worry and generalized worry, uncontrollable worry and anxiety, unable to relax and restlessness, and anxiety and fear of awful events. Among the fear of infection components, the strongest connection was between fear of infecting others and fear of being infected. There was a strong connection between the two financial worries components.

Among the loneliness components, the strongest connection was between missing companionship and feeling isolated. Across disorders, the GAD symptom restlessness was strongly connected to the MDD symptom psychomotor problems. There were no notable connections across the distressing states.

Centrality

The strength, closeness, and betweenness centrality z -scores are presented in Figure 2. Of the MDD symptoms, depressed mood, loss of energy and worthlessness had high strength ($z \geq 1$). Of the GAD symptoms, worry about many things, uncontrollability of worry, and trouble relaxing had high strength. Of the fear of infection components, fear of dying from the virus had the highest strength. Of the loneliness components, feeling isolated had high strength. These nodes followed a similar patterns on the closeness and betweenness dimensions, except that uncontrollability of worry had low betweenness and feeling isolated had low closeness.

Accuracy

The bootstrapped CIs for the edge-weights are shown in Figure 3. They were small, indicating that they were reasonably accurate and that many of them differed significantly from each other.

Stability

Figure 4 indicates a high stability of the centrality estimates. It shows that up to 75% of the sample could be dropped while retaining a correlation with the centrality estimates for the whole sample of 0.70 with 95% certainty.

Community analysis

The spin glass community analysis identified 5 clusters (communities) reported in Table 1. The first consisted of the three worry symptoms, the anxiety symptom of GAD and the two financial worry items. The second cluster consisted of the four loneliness items. The third community consisted of most MMD symptoms (anhedonia, depressed mood, disturbed sleep, low energy, appetite problems, worthlessness and suicidal ideation) and one GAD symptom (irritability). The fourth cluster consisted of the four infection fears and the GAD symptom fear of awful events. The fifth cluster consisted of symptoms from MDD and GAD reflecting cognitive and bodily symptoms.

Discussion

The present study investigated the network of the components of three salient pandemic-related distressing states (i.e., fear of infection, financial worries, loneliness) in addition to MDD and GAD symptoms in the general population during a period of strict social distancing protocols to impede the spread of the COVID-19 virus. The primary question was whether components of these psychological states were related to common psychiatric symptoms and – because they had likely been elicited or strengthened by the pandemic and the protocols - could be interpreted to influence the symptoms.

Of the infection fears, fear of dying from the coronavirus and fear of significant others dying from it had marked connections to the GAD symptom fear of awful events. These connections are reasonable, as dying from the virus or losing significant others are both examples of awful events. Fear of infection and fear of dying were connected to the GAD symptom anxiety. Thus, these infections fears and GAD symptoms may function as bridge components between the fear of infection and GAD constructs, explaining how the pandemic-related fear of infection may have the impact of activating a network of GAD-symptoms.

Of the financial worry components, worry about personal economy was connected to the MDD symptom sleep problems and to the GAD symptom generalized worry. Thus, financial worry may activate both the MDD and the GAD network.

Each of the four loneliness components was connected to a particular MDD symptom (e.g., missing companionship was connected to anhedonia). Thus, the loneliness that has been elevated by the presence of the social distancing measures may spread to depression symptoms through several paths and eventually activate an inter-connected network of depression symptoms.

The community analysis yielded five clusters: a depression cluster of six MDD symptoms and the GAD symptom irritability; a GAD worry cluster including worry uncontrollability, generalized worry, anxiety, worry about job, and worry about personal economy; a fear of infection cluster including the fear of infection components and the GAD symptom fear of awful events; a pure cluster of the loneliness components and, finally, an across disorder cluster of cognitive and bodily symptoms.

Centrality values depend on such coincidental features as number of items measuring a construct and the density of a construct's network, making it less informative to compare centrality values across constructs. However, within constructs, item centrality can give information about importance. Among the MDD symptoms, depressed mood, loss of energy, and worthlessness had the high strength, meaning that they uniquely explained much variance in the neighboring nodes. These findings fit well with those found in other studies conducted during non-pandemic times (Cramer *et al.*, 2010; Osborn *et al.*, 2020; Briganti *et al.*, 2020; Fried *et al.*, 2016; and Hakulinen *et al.*, 2020). Among the GAD symptoms, generalized worry, uncontrollability of worry, and trouble relaxing were those with highest strength centrality. This fits well with the results of Osborn *et al.* (2020) who also found generalized worry and uncontrollability of worry as those symptoms with highest strength. Fear of dying

had the highest strength among the fear of infection items, worry about personal economy had the highest strength among the financial worry items, and feeling isolated had the highest strength among the loneliness items. If these findings are replicated in longitudinal within-person studies, the central symptoms and components may possibly turn out to be promising targets for intervention.

Our findings are consistent with those found by Wang *et al.* (2020) in a study of depression and anxiety symptoms during the outbreak of the pandemic in China except that these authors also found restlessness, psychomotor problems and suicidality also to be central symptoms. Thus, bodily troubles and suicidality appeared to have more influence on other symptoms in China than in Norway.

A strength of this study is that it captured the effects of the social distancing protocols momentarily as they happened and were held constant during the measurement period. Thus, this study provides the grounds for evaluation and modification of these protocols in real time, as they are still in practice worldwide. Moreover, the large sample size contributed to accuracy, stability, and robustness of the network estimates. A limitation of this study is that random sampling was not conducted. However, the sample of respondents turned out to be relatively representative of the adult Norwegian population in terms of the proportion of subgroups. Notable exceptions were large proportions of females and of people with higher education. A second limitation is that the variables were assessed by self-report. Third, the centrality measures used are developed for social networks, and it is unclear to what extent they reflect the relationships between psychological variables (Bringmann *et al.*, 2019). We have focused strength centrality, which gives information on the strength of the direct connections (partial correlations) between a node and its neighboring nodes. However, this measure does not capture indirect associations between nodes. Empirically, the implication of network theory that strength centrality in cross-sectional networks predicts the strength of the

association between a symptom's change and the change in the severity of all other symptoms in the network from pre- to post-treatment has received mixed support (Spiller *et al.*, 2020). A fourth limitation is the cross-sectional design, which impairs the ability to draw conclusions about temporal precedence and greater insight into causal direction of the relationships obtained. The proposal that symptoms causally interact with each other implies that they do so within individuals over time and a more direct examination of these within-person interactions requires a longitudinal design. Finally, the sample was drawn from a general population. Thus, even though there were high levels of anxiety and depression, this was not a clinical sample. Hence other associations and network structure may be present in a clinical sample.

In sum, the findings support that the components of states elicited by the pandemic and the social distancing protocols are associated with depression and anxiety symptoms. Some of the fear of infection components were related to some GAD symptoms, the financial worry component worry about personal economy was related to a MDD symptom and a GAD symptom, and each of the loneliness components were related to a specific MDD symptom. The community analysis revealed both pure clusters of MDD and GAD symptoms as well as well as an across disorder cluster. Potential targets of interventions suggested by the findings for the complex of pandemic-related states and disorders are the symptoms anhedonia, depressed mood and worthlessness when focusing on MDD, the symptoms generalized worry, uncontrollability of worry, and inability to relax within a GAD cluster, the component fear of dying with regard to infection fears, and the component feeling isolated concerning loneliness. Future studies should use a longitudinal design and to estimate within-person networks and thereby more forcefully investigate whether the presented central variables may represent effective targets for intervention in pandemic settings.

References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th ed.)*. Washington, DC: Author.
- Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G.J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet*, 395(10227), 912–920.
[http://dx.doi.org/10.1016/S0140-6736\(20\)30460-8](http://dx.doi.org/10.1016/S0140-6736(20)30460-8)
- Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry*, 16(1), 5-13.
<http://dx.doi.org/10.1002/wps.20375>
- Briganti, G., Scutari, M., & Linkowski, P. (2020). Network structures of symptoms from the Zung Depression Scale. *Psychological Reports*.
<http://dx.doi.org/10.1177/0033294123942116>
- Bringmann, L. F., Elmer, T., Epskamp, S., Krause, R. W., Schoch, D., Wichers, M., Wigman, J., & Snippe, E. (2019). What do centrality measures measure in psychological networks? *Journal of Abnormal Psychology*, 128(8), 892-903.
<http://dx.doi.org/10.37/abn0000446>
- Cramer, A. O. J., Waldorp, L. J., van der Maas, H. L. J., & Borsboom, D. (2010). Comorbidity: A network perspective. *Behavioral and Brain Sciences*, 33, 137-193.
<http://dx.doi.org/10.1017/S01-40525X09991567>
- Csardi, G.; & Nepusz, T. (2006). The igraph software package for complex network research. *InterJournal, Complex Systems*, 1695. <https://igraph.org>.
- Ebrahimi, O. V., Hoffart, A., & Johnson, S. U. (2020). *The mental health impact of non-pharmacological interventions aimed at impeding viral transmission during the COVID-19 pandemic in a general adult population and the factors associated with*

adherence to these mitigation strategies. PsyArXiv.

<https://doi.org/10.31234/osf.io/kjzsp>

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, 50(1), 195-212.

<http://dx.doi.org/10.3758/s13428-017-0862-1>

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012).

qgraph: network visualizations of relationships in psychometric data. *Journal of Statistical Software*. 48(4), 1-18. <http://dx.doi.org/10.18637/jss.v048.i04>

Fried, E. I., Bockting, C., Arjadi, R., Borsboom, D., Amshoff, M., Cramer, A. O. J., Epskamp,

S., Tuerlinckx, & Carr, D. (2015). From loss to loneliness: the relationship between bereavement and depressive symptoms. *Journal of Abnormal Psychology*, 124(2), 256-265. [http://dx.doi.org/10.1016/S2215-0366\(20\)30168-1](http://dx.doi.org/10.1016/S2215-0366(20)30168-1)

Fried, E. I., Epskamp, S., Nesse, R. M., Tuerlinckx, F., & Borsboom, D. (2016). What are “good” depression symptoms? Comparing the centrality of DSM and non-DSM symptoms of depression in a network analysis. *Journal of Affective Disorders*, 189, 314-320. <http://dx.doi.org/10.1016/j.jad.2015.09.005>

Fruchterman, T. M. J., & Reingold, E. M. (1991). Graph drawing by force-directed placement. *Software: Practice and Experience*, 21(11), 1129-1164.

<http://dx.doi.org/10.1002/spe.4380211102>

Hakulinen, C., Fried, E. I., Pulkki-Råback, L., Virtanen, M., Suvisaari, J., & Elovainio, M. (2020). Network structure of depression symptomatology in participants with and without depressive disorder: the population-based Health 2000-2011 study. *Social Psychiatry and Psychiatric Epidemiology*, 55(10), 1273-1282.

<http://dx.doi.org/10.1007/s00127-020-01843-7>

- Hays, R. D., & DiMatteo, M. R. (1987). A short-form measure of loneliness. *Journal of Personality Assessment*, 51(1), 69-81.
- Hoffart, A., Johnson, S. U., & Ebrahimi, O. V. (2020). Loneliness and social distancing during the COVID-19 pandemic: Risk factors and associations with psychopathology. *Frontiers in Psychiatry*. 11:589127. <http://dx.doi.org/10.3389/fpsyt.2020.589127>
- Kendler, K. S., Zachar, P., & Craver, C. (2011). What kind of things are psychiatric disorders? *Psychological Medicine*, 41(6), 1143-1150.
<http://dx.doi.org/10.1017/S00332917100001844>
- Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Archives of General Psychiatry*, 62(6), 593-602. <http://dx.doi.org/10.1001/archpsyc.62.6.593>
- Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16(9), 606–613.
[http://dx.doi.org/10.1016/S2215-0366\(20\)30168-1](http://dx.doi.org/10.1016/S2215-0366(20)30168-1)
- McNally, R. J., Robinaugh, D. J., Wu, G. W., Wang, L., Deserno, M. K., & Borsboom, D. (2015). Mental disorders as causal systems: A network approach to posttraumatic stress disorder. *Clinical Psychological Science*, 3(6), 836-849.
<http://dx.doi.org/10.1177/467702614553230>
- Norwegian Institute of Public Health. (2016). Mental illness among adults in Norway. In: *Public Health Reports – Health Status in Norway*.
<https://www.fhi.no/en/op/hin/mental-health/psykisk-helse-hos-voksne/> (accessed Apr 24, 2020).
- Office for National Statistics (2018). *Loneliness – what characteristics and circumstances are associated with feeling lonely?* <http://www.ons.gov.uk/>

- Opsahl, T., Agneessens, F., & Skvoretz, F. (2010). Node centrality in weighted networks: Generating degree and shortest paths. *Social Networks*, 32(3), 245-251.
<http://dx.doi.org/10.1016/j.socnet.2010.03.006>
- Osborn, T. L., Campbell, S., Weisz, J. R., & Ndeti, D. M. (2020). Network analysis reveals central symptoms of adolescent depression and anxiety in Sub-Saharan Africa. PsyArXiv. <http://dx.doi.org/10.31234/osf.io/dv6c9>
- R Core Team (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>
- Reichardt, J., & Bornholdt, S. (2006). Statistical mechanics of community detection. *Physics Review*, E74(1), 016110. <http://dx.doi.org/10.1103/PhysRevE.74.016110>
- Salari, N., Hosseini-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammad, M., Rasoulpoor, S., & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Globalization and Health*, 16:57. <http://dx.doi.org/10.1186/s12992-020-00589-w>
- Shamir, B. (1986). Self-esteem and the psychological impact of unemployment. *Social Psychology Quarterly*, 49(1), 61-72. <https://www.jstor.org/stable/2786857>
- Spiller, T. R., Levi, O., Neria, Y., Suarez-Jimenez, B., Bar-Haim, Y., & Lazarov, A. (2020). On the validity of the centrality hypothesis in cross-sectional between-subjects networks of psychopathology. *BMC Medicine* 18, 297.
<http://dx.doi.org/10.1186/s12916-020-01740-w5>
- Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine*, 166(10), 1092-1097. [http://dx.doi.org/10.1016/S2215-0366\(20\)30168-1](http://dx.doi.org/10.1016/S2215-0366(20)30168-1)
- Statistics Norway (2019). <https://www.ssb.no/utniv/>

- Wang, Y., Hu, Z., Feng, Y., Wilson, A., & Chen, R. (2020). Changes in network centrality of psychopathology symptoms between the COVID-19 outbreak and after peak. *Molecular Psychiatry*. <http://dx.doi.org/10.1038/s41380-020-00881-6>
- Wells, A. (2009). *Metacognitive therapy for anxiety and depression*. New York, NY: The Guilford Press.
- Williams, D., & Rast, P. (2018). Back to the basics: Rethinking partial correlation network methodology. *British Journal of Mathematical and Statistical Psychology*, 73(2), 187-212. <http://dx.doi.org/10.1111/bmsp.12173>
- Yanguas, J., Pinazo-Henandis, S., & Tarazona-Santabalbina, F. J. (2011). The complexity of loneliness. *Acta Biomedica*, 89(2), 302-314. <http://dx.doi.org/10.23750/abm.v89i2.7404>

Table 1. Descriptive statistics for the network variables

Construct/nodes	Label	<i>M</i>	S.D.	Skewness	Kurtosis	Cluster
MDD						
Anhedonia	D1	1.01	0.88	0.76	0.03	3
Depressed mood	D2	0.90	0.86	0.88	0.28	3
Disturbed sleep	D3	1.08	1.02	0.63	-0.72	3
Low energy	D4	1.32	0.89	0.49	-0.48	3
Appetite problems	D5	0.98	1.00	0.71	-0.60	3
Worthlessness	D6	0.86	0.95	0.93	-0.07	3
Trouble concentrating	D7	0.87	0.96	0.88	-0.21	5
Psychomotor problems	D8	0.41	0.73	1.86	3.00	5
Suicidal ideation	D9	0.19	0.55	3.36	11.93	3
GAD						
Anxiety	A1	0.91	0.89	0.86	0.08	1
Uncontrollable worry	A2	0.65	0.87	1.28	0.85	1
Generalized worry	A3	0.99	0.91	0.77	-0.11	1
Trouble relaxing	A4	0.92	0.92	0.84	-0.07	5
Restlessness	A5	0.55	0.77	1.42	1.64	5
Irritability	A6	1.05	0.86	0.68	-0.04	3
Fear of awful events	A7	0.66	0.81	1.23	1.08	4
Fear of infection						
Fear of significant others dying	F1	1.33	1.00	0.40	-0.90	4
Fear of infecting others	F2	1.09	0.91	0.66	-0.27	4
Fear of being infected	F3	0.72	0.79	1.14	1.17	4
Fear of oneself dying	F4	0.36	0.66	2.11	4.67	4

Financial worry

Worry about losing job	W1	0.53	0.87	1.64	1.72	1
Worry about personal economy	W2	0.98	1.04	0.79	-0.59	1

Loneliness

Missing companionship	L1	1.79	0.96	-0.30	-0.89	2
Feeling left out	L2	1.15	0.88	0.33	-0.67	2
Feeling isolated	L3	1.42	1.02	0.05	-1.13	2
People around but not with	L4	1.16	0.94	0.36	-0.81	2

MDD = major depressive disorder, GAD = generalized anxiety disorder.

Fig. 1. Estimated partial correlation network of symptoms of major depressive disorder as measured by the Patient Health Questionnaire-9 (D1-D9), of symptoms of generalized anxiety disorder as measured by the Generalized Anxiety Disorder-7 (A1-A7), of components of fear of infection (F1-F4), of components of financial worry (W1-W2) and of components of loneliness as measured by the UCLA Loneliness Scale-8 (L1-L4). Blue lines represent positive associations, red lines represent negative associations, and the thickness of an edge indicates the association strength. Absence of edges between nodes denotes statistical independence (colour online).

Fig. 2. Centrality indices of node strength, closeness and betweenness of the estimated network. Indices are shown as standardized z -scores. See Figure 1 or Table 1 for description of the labels.

Fig. 3. Bootstrapped confidence intervals of estimated edge weights.

Fig. 4. Case-dropping bootstrap procedure for node centrality indices. Full line indicates the mean correlation while the colored area indicates the 2.5th quartile to the 97.5th quartile range.

Supplementary Material

Supplementary Figure A. Edge weight differences in the network of stress-related pandemic states, depression, and anxiety symptoms.

Open data: Correlation matrix necessary to reproduce the results. A picture of correlation matrix is attached for spatial reasons. The correlation matrix file may be requested by any of the authors.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	A1	A2	A3	A4	A5	A6	A7	F1	F2	F3	F4	W1	W2	L1	L2	L3	L4	
D1		1	0.6616960	0.4591380	0.5865146	0.4913804	0.5181257	0.4859733	0.3425876	0.4026547	0.4319757	0.4728300	0.4690362	0.4668507	0.3073405	0.4243729	0.3272858	0.1455372	0.1502610	0.1783568	0.1113974	0.1806976	0.2867705	0.3645019	0.3302599	0.3925954	0.3044663
D2	0.6616960		1	0.4998736	0.5700357	0.4958388	0.6146140	0.5238622	0.4066828	0.4868102	0.5819725	0.6137258	0.6064904	0.5755585	0.3652924	0.4917535	0.4579111	0.1979213	0.1681904	0.2101371	0.1777989	0.2015479	0.3082475	0.3908275	0.3812115	0.4439330	0.3416960
D3	0.4591380	0.4998736		1	0.5531222	0.4731400	0.4462589	0.4362489	0.3399538	0.3367609	0.4089636	0.4536692	0.4329038	0.4809091	0.3189137	0.3433344	0.3339649	0.1809309	0.1461475	0.1798149	0.1388260	0.1440356	0.2731569	0.2851751	0.2922119	0.3211339	0.2544423
D4	0.5865146	0.5700357	0.5531222		1	0.5435284	0.5095657	0.4821212	0.3121448	0.3371194	0.4341209	0.4535941	0.4606776	0.4843473	0.2802914	0.4381684	0.3387942	0.1805953	0.1729928	0.2192422	0.1303579	0.1633803	0.2820968	0.3207676	0.3238565	0.3691346	0.2755083
D5	0.4913804	0.4958388	0.4731400	0.5435284		1	0.4967889	0.4586625	0.3563270	0.3365012	0.4029545	0.4388282	0.4209500	0.4619876	0.3265542	0.3962841	0.3336820	0.1754787	0.1677751	0.1959970	0.1410630	0.1721467	0.2817366	0.3179054	0.3258209	0.3575831	0.2882525
D6	0.5181257	0.6146140	0.4462589	0.5095657	0.4967889		1	0.5185679	0.3786056	0.4717365	0.4804402	0.5326238	0.5364267	0.5253920	0.3254769	0.4712446	0.3830904	0.1697148	0.1683882	0.1766022	0.1153341	0.1966831	0.3200437	0.3283596	0.4000686	0.3916768	0.3453543
D7	0.4859733	0.5238622	0.4362489	0.4821212	0.4586625	0.5185679		1	0.4422445	0.3677897	0.4423863	0.4678124	0.4580841	0.5481467	0.4217301	0.4073132	0.3361798	0.1613732	0.1632880	0.1953575	0.1162628	0.1678524	0.2597668	0.3021589	0.3110691	0.3448874	0.2950643
D8	0.3425876	0.4066828	0.3399538	0.3121448	0.3563270	0.3786056	0.4422445		1	0.3341416	0.3636415	0.3848137	0.3768953	0.4439602	0.5110247	0.3382822	0.3002395	0.1256863	0.1202148	0.1372568	0.0999908	0.1437528	0.2116082	0.2453656	0.2529217	0.2926187	0.2392895
D9	0.4026547	0.4868102	0.3367609	0.3371194	0.3365012	0.4717365	0.3677897	0.3341415		1	0.3521841	0.4199771	0.3632716	0.3845770	0.2781689	0.2807633	0.2853683	0.0828873	0.0863128	0.0830588	0.0980638	0.0894642	0.1867618	0.2176018	0.3051888	0.2773653	0.2780025
A1	0.4319757	0.5819725	0.4089636	0.4341209	0.4029545	0.4804402	0.4423863	0.3636415	0.3521841		1	0.7120990	0.6993071	0.6221452	0.3675190	0.4218600	0.6004122	0.2876705	0.2396078	0.3092404	0.3037003	0.2043636	0.2929060	0.2981363	0.3010557	0.3595416	0.2788321
A2	0.4728300	0.6137258	0.4536692	0.4535941	0.4388282	0.5326238	0.4678124	0.3848137	0.4199771	0.7120990		1	0.7536624	0.6390204	0.3934759	0.4296674	0.5792322	0.2588458	0.2110427	0.2552928	0.2723924	0.1959206	0.2987300	0.2877014	0.3244278	0.3611709	0.2961964
A3	0.4690362	0.6064904	0.4329038	0.4606776	0.4209500	0.5364267	0.4580841	0.3768953	0.3632716	0.6993071	0.7536624		1	0.6453743	0.3768274	0.4632218	0.5870919	0.2874166	0.2238293	0.2696594	0.2569172	0.2181668	0.3339111	0.3125648	0.3242671	0.3779402	0.2989807
A4	0.4668507	0.5755585	0.4809091	0.4843473	0.4619876	0.5253920	0.5481467	0.4439602	0.3845770	0.6221452	0.6390204	0.6453743		1	0.5140779	0.4752999	0.4846970	0.2182892	0.1874858	0.2364797	0.2167890	0.1747488	0.2909008	0.3194048	0.3355901	0.3760328	0.3204227
A5	0.3073405	0.3652924	0.3189137	0.2802914	0.3265541	0.3254769	0.4217301	0.5110247	0.2781689	0.3675190	0.3934759	0.3768274	0.5140779		1	0.3572668	0.2810378	0.1157601	0.1240279	0.1303659	0.0942778	0.1591880	0.2233948	0.2571614	0.2177736	0.2945029	0.2130992
A6	0.4243729	0.4917535	0.3433344	0.4381684	0.3962841	0.4712446	0.4073131	0.3382822	0.2807633	0.4218599	0.4296674	0.4632218	0.4752999	0.3572668		1	0.3441967	0.1559275	0.1352432	0.1526048	0.0819743	0.1810379	0.2539704	0.2862862	0.3005750	0.3349129	0.2739407
A7	0.3272858	0.4579111	0.3339649	0.3387942	0.3336820	0.3830904	0.3361798	0.3002395	0.2853683	0.6004122	0.5792322	0.5870919	0.4846970	0.2810378	0.3441967		1	0.3806570	0.2633736	0.3325379	0.4267756	0.1592406	0.2360736	0.2346250	0.2460067	0.2986636	0.2265311
F1	0.1455372	0.1979213	0.1809309	0.1805953	0.1754787	0.1697148	0.1613731	0.1256863	0.0828873	0.2876705	0.2588458	0.2874166	0.2182892	0.1157601	0.1559275	0.3806570		1	0.3240889	0.3050077	0.3443159	0.1238977	0.1662317	0.1186468	0.0986227	0.1549691	0.1040443
F2	0.1502610	0.1681904	0.1461475	0.1729928	0.1677751	0.1683882	0.1632880	0.1202148	0.0863128	0.2396078	0.2110427	0.2238293	0.1874858	0.1240279	0.1352432	0.2633736	0.3240889		1	0.4585259	0.1723670	0.0880318	0.1071454	0.1103000	0.0931913	0.1201952	0.0932639
F3	0.1783568	0.2101371	0.1798149	0.2192422	0.1959970	0.1766022	0.1953575	0.1372568	0.0830588	0.3092404	0.2552928	0.2696594	0.2364796	0.1303659	0.1526048	0.3325379	0.3050077	0.4585259		1	0.3523071	0.0999465	0.1334756	0.1193809	0.1406228	0.1541108	0.1222262
F4	0.1113974	0.1777989	0.1388260	0.1303579	0.1410629	0.1153341	0.1162628	0.0999908	0.0980638	0.3037003	0.2723924	0.2569172	0.2167890	0.0942778	0.0819743	0.4267756	0.3443159	0.1723670	0.3523071		1	0.0295606	0.0917997	0.0748999	0.1269290	0.1287917	0.1106855
W1	0.1806976	0.2015478	0.1440356	0.1633803	0.1721467	0.1966831	0.1678524	0.1437528	0.0894642	0.2043636	0.1959205	0.2181668	0.1747488	0.1591880	0.1810379	0.1592406	0.1238977	0.0880318	0.0999465	0.0295606		1	0.6064080	0.1284401	0.1366134	0.1510402	0.1350752
W2	0.2867705	0.3082475	0.2731569	0.2820968	0.2817366	0.3200437	0.2597668	0.2116082	0.1867618	0.2929060	0.2987300	0.3339111	0.2909008	0.2233948	0.2539704	0.2360736	0.1662317	0.1071454	0.1334756	0.0917997	0.6064080		1	0.1976106	0.2383233	0.2515637	0.2196929
L1	0.3645019	0.3908275	0.2851751	0.3207676	0.3179053	0.3283596	0.3021589	0.2453655	0.2176018	0.2981363	0.2877014	0.3125648	0.3194048	0.2571614	0.2862862	0.2346250	0.1186468	0.1103000	0.1193809	0.0748999	0.1284401	0.1976106		1	0.4319485	0.6489161	0.3694569
L2	0.3302598	0.3812115	0.2922119	0.3238565	0.3258209	0.4000686	0.3110691	0.2529217	0.3051888	0.3010557	0.3244278	0.3242671	0.3355901	0.2177736	0.3005750	0.2460067	0.0986227	0.0931913	0.1406228	0.1269290	0.1366134	0.2383233	0.4319485		1	0.5434510	0.5009037
L3	0.3925954	0.4439330	0.3211339	0.3691346	0.3575831	0.3916768	0.3448874	0.2926187	0.2773653	0.3595416	0.3611709	0.3779402	0.3760328	0.2945029	0.3349129	0.2986636	0.1549691	0.1201952	0.1541108	0.1287917	0.1510402	0.2515637	0.6489161	0.5434510		1	0.4400879
L4	0.3044663	0.3416960	0.2544423	0.2755083	0.2882525	0.3453543	0.2950643	0.2392895	0.2780025	0.2788321	0.2961964	0.2989807	0.3204227	0.2130992	0.2739407	0.2265311	0.1040443	0.0932639	0.1222262	0.1106855	0.1350752	0.2196929	0.3694569	0.5009037	0.4400879		1

R Code

```
# Load packages:
library("bootnet")
library("qgraph")
library("dplyr")

# Import csv file
Data <- read.csv("NWdepanx.csv")
View(Data)

DataAllAdults <- Data[,13:38]
View(DataAllAdults)

# Estimate network using the Graphical Gaussian Model Modselect algorithm
# Use glasso to fit the network structure
# Continue by obtained through maximum likelihood estimation
# until BIC is optimized

netAllAdults <- estimateNetwork(
  DataAllAdults,
  default = "ggmModSelect",
  corMethod = "spearman"
)

# Plot network
plot (netAllAdults,
      layout = "spring",
      theme = "colorblind",
      groups = groupObject,
      nodeNames = namesObject,
      legend.cex = 0.4,
```



```

filetype = "pdf", filename = "1) ggmModSelect Network 26 names")

pdf("2) Centrality - ALL adults names - ggmModSelect.pdf")

# Centrality plot:
centralityPlot(netAllAdults,
               include = c("Strength", "Closeness", "Betweenness"))

dev.off()

# Inspect edge weight accuracy
# using non-parametric with 1000 boots
bootEW_nonparametric <- bootnet(
  netAllAdults,
  nBoots = 1000,
  nCores = 4,
  split0 = TRUE
)

View(summary(bootEW_nonparametric))

pdf("3) Edge Weight Accuracy - All Adults - ggmModSelect.pdf")

# Plot edge weight accuracy
plot(bootEW_nonparametric,
     order = "sample",
     labels = FALSE,
     split0 = TRUE,
     plot = "interval")

dev.off()

pdf("4) Edge Weight Differences - All Adults - ggmModSelect.pdf")

```

```

# Plot edge differences
plot(bootEW_nonparametric,
     plot = "difference",
     onlyNonZero = TRUE,
     order = "sample")

dev.off()

# Finding node strength differences
pdf("5) Node strength differences - All adults names - ggmModSelect.pdf")

# Compare significant differences in node strength
# Weird to me that this uses the edge weight accuracy bootstrap object rather than the
# centrality stability case-drop bootstrap object?
plot(bootEW_nonparametric, "strength")

dev.off()

# Inspect centrality stability
# using case-drop with 1000 boots
boot_casedrop <- bootnet(
  netAllAdults,
  nBoots = 1000,
  nCores = 4,
  type = "case",
  statistics = c("strength", "betweenness", "closeness"))

pdf("6) Centrality stability - All adults names - ggmModSelect.pdf")

# Plot centrality stability:
plot(boot_casedrop,
     statistics = c("strength", "betweenness", "closeness"))

dev.off()

```

Reveal correlation stability coefficient for centrality indices:

`corStability(boot_casedrop)`

strength = 0.75 (stable), closeness = 75 (stable),

betweenness = 0.67 (stable)