Internalizing Symptoms and Social Support Among Kenyan Adolescents: A Network Analysis

Running Head: INTERNALIZING SYMPTOMS AND SOCIAL SUPPORT NETWORK

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Abstract

Internalizing symptoms are common and debilitating among adolescents. Network analysis, which models associations among psychopathology, risk factors, and protective factors, may help clarify relationships between social support and internalizing symptoms, including within understudied cultural groups. We performed network analyses of 1) depressive and anxiety symptoms, 2) social support, and 3) all three measures among 658 Kenyan adolescents. In the internalizing symptoms network, worry, nervousness, and feeling down exhibited the highest expected influence. In the social support network, friends showed the greatest expected influence. In the full network, social support from family, friends, and significant others were all negatively associated with internalizing symptoms, and feeling down was a particularly important bridge node between internalizing symptoms and social support. Our findings suggest that feeling down is closely linked to social support in this sample of Kenyan adolescents. The study illustrates the potential of network analysis to aid understanding of psychopathology cross-culturally.

Keywords: Depression, Anxiety, Social Support, Developmental Psychopathology, Network Analysis

Internalizing Symptoms and Social Support Among Adolescents: A Network Analysis

Depression and anxiety symptoms are common and costly worldwide, and often emerge during adolescence; 20% of the global population will experience depression or anxiety before the age of 18 (Costello et al., 2003). Even at subclinical levels, symptoms of depression and anxiety can lead to increased health problems, decreased school attendance, and risky behaviors such as drug and alcohol consumption (Wright et al., 2016; King and Bernstein, 2001). Additionally, greater depressive symptoms in adolescence predict suicide attempts both in adolescence and later in adulthood (Fergusson, Horwood, Ridder, & Beautrais, 2005), and mental disorders in adolescents often predict the chronic recurrence of mental disorders in adulthood (Himle et al., 2009).

Anxiety and depression exhibit high rates of comorbidity, and adolescent depression often follows from childhood anxiety (Garber & Weersing, 2010). One explanation for these relatively high rates of comorbidity is the high symptom overlap between the two disorders. For instance, fatigue, concentration difficulties, and restlessness are often considered symptoms of both disorders, and both disorders involve significant distress, negative affect, and functional impairment (Garber & Weersing, 2010). An alternative possibility is that depression and anxiety symptoms can cause one another. For instance, anxiety might lead to social avoidance, which might lead to loneliness, which is a risk factor for depression (Borsboom & Cramer, 2013). Although the view that depression and anxiety symptoms can cause one another is clinically plausible, there is insufficient research to determine precisely how specific symptoms of depression and anxiety relate to one another.

Social Support, Depression, and Anxiety

One important domain of functional impairment in both adolescent depression and anxiety is social functioning. Social support is related to symptoms of psychopathology across the lifespan (Kessler, Price, & Wortman, 1985). Social support is well established as a protective factor against internalizing symptoms (Rosario et al., 2007; Coker, Smith, & Thompson, 2002) and may play a particularly important role in adolescent psychopathology. Specifically, positive social support is theorized to act directly to improve wellbeing, and to act indirectly as a protective buffer against risk factors for psychopathology (Patel et al., 2007; Zimet et al., 1988). Research suggests that social support may be especially important during adolescence because it is a period of stressful physical, social, and environmental changes (Newman et al., 2007). For example, adolescence is often a time of individuation from family, increased reliance on peers, and experimentation with romantic relationships.

It is important to recognize that social support is not a singular construct. Social support is often divided into multiple sub-components, which may have unique and differential influences on internalizing symptoms. For example, perceived and objective social support often come apart, with perceived social support showing a stronger relationship with depression and anxiety (Saronsen et al., 1985). Additionally, some sources of social support may matter more than others for determining psychological outcomes. One study of adolescents living in resource-poor environments found that family support and neighborhood connection were particularly important buffers against symptoms of depression and posttraumatic stress disorder (Cheng et al., 2014). Changes in peer and parent support are especially related to depressive symptoms during the transition to high school (Newman et al., 2007). Moreover, family, peer, and school problems have been found to be proximal risk factors for the development and maintenance of

mental health problems in older children and adolescents (Kieling et al., 2011). Thus, there is strong evidence that social support is related to symptoms of depression and anxiety. However, few studies have examined the relationships between specific aspects of social support on specific symptoms of depression and anxiety. Given that different symptoms are differentially related to functional outcomes (Fried & Nesse, 2014), it may be important to analyze which specific aspects of social support are most related to which symptoms.

Using Network Analysis to Analyze Symptoms and Social Support

Traditionally, psychologists have understood psychological disorders as symptoms arising from a latent, or underlying, brain disease (Insel, 2014). In this model, the latent disease "depression" gives rise to the symptoms of depression such as feeling sad, guilty, and worthless, and having sleep problems. Just as a tumor in the lungs might give rise to symptoms including shortness of breath and coughing up blood, a latent abnormality in the brain might give rise to sadness and sleep problems. Systems of mental disorder classification such as the DSM-5 implicitly follow a model of observable symptoms that reflect the presence of a latent disorder (APA, 2013).

Recently, an alternative model of psychopathology has increased in popularity, conceptualizing mental disorders as networks of interrelated symptoms. Network theories do not assume that symptoms emerge from a latent disease (Borsboom and Cramer, 2013; McNally, 2016). Instead, under the network approach, symptoms themselves and their dynamic interactions constitute mental disorders. For example, in the case of depression, feeling sad and worthless could lead to trouble sleeping, which could lead to concentration and eating problems. Importantly, this interacting group of symptoms *is* what constitutes depression. This has made network analysis an especially appealing tool for studies aiming to understand comorbidity (e.g.,

Heeren, Jones, & McNally, 2018) and protective factors for specific symptoms (e.g., Jayawickreme et al., 2017).

The output of a network analysis is a graphical representation of relationships between symptoms and other factors related to psychopathology known as a symptom network. Symptom networks consists of "nodes," which are the components involved in psychopathology (e.g., feeling sad or down) and edges, which are psychometric relationships between these components (e.g., partial correlations, regression parameters; Borsboom & Cramer, 2013; Fried et al., 2017). Importantly, researchers often use measures of node or symptom "centrality" when analyzing symptom networks in psychopathology research. Centrality is a measure of how strongly connected a node is to other nodes. This may make them ideal targets for prevention and intervention, as intervening upon these highly central symptoms may be most likely to result in the dissolution of the whole network of symptoms (McNally, 2016). Although centrality alone is far from a perfect indicator of which symptoms should most effectively be targeted (Rodebaugh et al., 2018), some empirical evidence shows that level of central symptoms at baseline uniquely predicts treatment outcomes, supporting the importance of centrality for prevention and intervention (Haag, Robinaugh, Ehlers, & Kleim, 2017; Elliott, Jones, & Schmidt, 2018).

Network analysis helps to explain some aspects of psychopathology that are insufficiently explained by the latent disease approach. Specifically, network analysis allows researchers to explore the nature of comorbidity, particularly by examining the relationships between individual symptoms, and determining which symptoms across disorders are most related to each other (Fried et al., 2017). Additionally, some empirical evidence suggests that certain symptoms may be more important than others in the development, severity, and effects of mental disorders. For example, according to one estimate, hypersomnia accounts for only 0.7% of the impairment

caused by MDD while sad mood accounts for 20% (Fried & Nesse, 2014). These differences in the importance of certain symptoms for determining clinical and functional outcomes can be analyzed using the network approach (Fried et al., 2017). Finally, network analyses can be used to analyze the effects of protective factors and risk factors on specific symptoms of psychopathology (McNally, 2016).

In this way, network analysis could help elucidate the precise ways in which certain aspects of social support relate to certain aspects of psychopathology, which may assist in developing more precise theories of how social support affects mental health and in preventing or treating psychopathology. Network analysis can also help researchers to measure the relative importance of symptoms in psychopathology and life outcomes (McNally, 2016). For example, measures of centrality can help determine which symptoms are most connected to other symptoms and lifestyle factors, identifying potential targets for intervention.

Past empirical network analyses have primarily examined symptom networks of adults from the United States and Europe with psychological disorders, especially depression. Several studies have examined networks of depressive symptoms (e.g., Bos et al., 2018; Fried et al., 2016; McElroy, Fearon, Belsky, Fonagy, & Patalay, 2018; Jones, Mair, Riemann, Mugno, & McNally, 2018, Wasil, Venturo-Conerly, Shinde, Patel, & Jones, 2019). Sad mood, anhedonia or loss of interest, and low energy or fatigue emerged most consistently as central symptoms of depression. Some network analyses have also examined the network structure of comorbid depression and anxiety symptoms in adults (e.g., Beard et al., 2016; Fischer et al., 2017, Langer et al., 2018). Finally, several past studies have examined networks of psychopathology in young people in the USA (Jones et al., 2018; Mullarkey et al., 2018; McElroy and Patalay, 2019; Boscholoo et al., 2016) and India (Wasil, Venturo-Conerly, Shinde, Patel, & Jones, 2019). However, none of these

studies on adolescents analyzed networks including both internalizing symptoms and risk or protective factors for psychopathology.

One network analysis study of Sri Lankan war survivors analyzed relationships between internalizing symptoms and life stressors including social problems such as living in camps (Jayawickreme et al., 2017). Interestingly, social problems emerged as the most central items in the network, surpassing even traumatic events and economic problems. This suggests that social factors may be especially important to study in network analyses, as they may also be highly influential in other samples. Yet, this is the only study to analyze social problems, and no past studies have analyzed networks of internalizing symptoms and positive aspects of social support.

Thus far, most previous network analyses have examined adults in high-income, western countries. More research is necessary to come to meaningful conclusions about the network structure of internalizing symptoms, especially in youth and individuals in low-income, non-western countries. Notably, symptom networks may differ between adolescents in different countries for many reasons including cultural differences in parenting practices, social traditions, implicit rules of self-presentation, extent of stigma, and level of access to treatment (Patel et al., 2007). This possibility highlights the potential benefit of applying network analysis to adolescents within specific cultural groups, to map associations and clarify potentially distinctive connections among symptoms and social variables.

Using Networks to Understand Depression and Anxiety in Low-Income Regions

As noted previously in the manuscript, network analysis has proven to be a valuable tool for analyzing the relationship between symptoms of psychopathology and social processes (e.g., Jayawickreme et al., 2017). One important aspect of networks of psychopathological factors is that they are likely to be at least somewhat unique to specific populations (Boorsboom &

Cramer, 2013). This may mean that network analysis may be an especially useful tool in efforts to understand psychopathology in specific cultural groups and social contexts. This present study reflects that perspective by using network analysis to map the relationships between social support and psychopathology in a unique and understudied sample and sociocultural context. Specifically, this study applies network analysis to a population of youths living in Nairobi, Kenya, many of whom live in Kibera, the largest slum in Africa (Kenya National Bureau of Statistics, 2009). In Kenya, as in many developing countries around the world, stigma and lack of mental health resources compound the typical clinical, social, educational, and functional issues that accompany mental illness (Semrau et al., 2015). Even among Kenyan primary school children between ages 6 and 13, one study detected high rates of stigma against mental illness (Ndetei et al., 2016). Additionally, in low-income regions lack of investment in mental health infrastructure and providers leads to significant gaps in care for youth with mental illness (Patel et al., 2007).

Finally, the nature of the Kenyan education system places unique academic pressures on high school students. At the end of primary school, students are required to take a national test that determine the kind of high school in which they gain admission (Ndetei et al, 2008; Osborn, Venturo-Conerly, Wasil, Schleider, & Weisz, 2019, under review). As a result, some students gain admission to low-quality schools and may experience hardships and lack of prospects that can exacerbate mental health issues (Dashiff, DiMicco, & Myers, 2009). Regardless, students at many high schools experience immense pressure from their teachers and families to achieve academic success as measured by the end of the secondary-school examination, Kenya Certificate of Secondary Education (KCSE). KCSE scores determine college eligibility and future job prospects (Gitome, Katola, & Nyabwari, 2013) and as a result, older Kenyan

adolescents about to sit for the exam face increased pressure to succeed (Philias & Wanjobi, 2009). The nature of the education system and the lack of mental health resources, combined with financial pressures and the boarding school context, make Kenyan high school students a psychosocially distinctive population.

This Present Study

The present study used network analysis to examine relationships between depressive symptoms, anxiety symptoms, and social support in Kenyan adolescents. Specifically, it identifies the most central psychopathology nodes and social support nodes and provides graphical representations of the relationship between these internalizing symptoms and various aspects of social support. Finally, this study identifies factors and symptoms that most strongly link depressive to anxiety symptoms, and that most strongly link social support and internalizing symptoms. Importantly, no prior network analyses of social support and internalizing symptoms have been conducted in a sample of this kind. Therefore, no specific hypotheses were advanced for this study.

Methods

Participants

We used baseline data from the Shamiri Trial, a study of adolescents living in Kibera, Kenya, a highly populous slum. The Shamiri Trial is more extensively documented elsewhere (Osborn, Wasil, Venturo-Conerly, Schleider, & Weisz, 2019, in revisions). Adolescents were eligible to participate in the baseline data collection if they consented to participate and were students at participating high schools. The study was approved by the Harvard University IRB. The study team received consent or assent from adolescents and from school principals, who, according to local customs, serve as the students' guardians during the school year.

We analyzed a sample of 658 adolescents (51.37% female; M_{age} = 15.85, SD_{age} = 1.41) attending high schools in Nairobi, Kenya. These participants came from diverse high schools. Three schools were public and two were private; three were in the slum of Kibera and two in the suburbs of Nairobi. Two were low-resourced, one was medium-resourced, and two were high-resourced (see Osborn, Venturo-Conerly, Wasil, Schleider, & Weisz, 2019, under review for details).

Materials and Measures

Kenyan high school students completed measures of depression, anxiety, perceived social support, and other health-related and demographic variables (see Osborn, Venturo-Conerly, Wasil, Schleider, & Weisz, 2019, under review). To measure depression, we used the Patient Health Questionnaire-8 (PHQ-8; Kroenke & Spitzer, 2002; Kroenke et al., 2009), the 8-item version of a 9-item questionnaire assessing severity of depression. We excluded the 9th item which assesses suicidality at the request of local Kenyan administrators. PHQ-8 scores correlate highly with PHQ-9 scores, and the same cutoffs are recommended to classify depression severity (Kroenke & Spitzer, 2002). It has been validated on samples from Kenya (Omoro, Fann, Weymuller, MacHaria, & Yueh, 2006). Cronbach's alpha was 0.73 in this present sample of Kenyan adolescents. The PHQ-8 asks respondents how often they have experienced symptoms including "Little interest or pleasure in doing things" and "Feeling tired or having little energy" over the last two weeks. Scoring is from 0 ("Not at all") to 3 ("Nearly every day").

To measure anxiety, we used the Generalized Anxiety Disorder Screener (GAD-7; Spitzer et al., 2006). It has demonstrated strong validity, and good internal consistency with a Cronbach's alpha of 0.92 in a study of North American children and adolescents (Spitzer et al., 2006). Cronbach's alpha for Kenyan adolescents in present study was 0.78. The GAD-7 asks

respondents how frequently they have experienced symptoms including “Not being able to stop or control worrying about things” and “Feeling afraid as if something bad might happen” over the last two weeks. Scoring is from 0 (“Not at all”) to 3 (“Nearly every day”).

The Multidimensional Scale of Perceived Social Support (MSSS; Zimet et al., 1988) is a measure of perceived social support. It has 12 items, broken into three four-item subscales: Family, Friends, and Significant Others. In this present study of Kenyan adolescents, Cronbach’s alpha for the full MSSS was 0.86; for the Significant Other subscale Cronbach’s alpha was 0.79, for the Family subscale it was 0.80, and for the Friends subscale 0.86. It asks respondents how strongly they agree with statements such as “My friends really try to help me” and “There is a special person who is around when I am in need.” Items are scored from 1 (“I Very Strongly Disagree”) to 7 (“I Very Strongly Agree”).

In this sample, the mean PHQ-8 score was 9.25 (*SD* = 5.20), the mean GAD-7 score was 8.16 (*SD* = 5.02), and the mean total MSSS score was 5.09 (*SD* = 1.16). Many participants met clinical cutoffs for anxiety and depression, with 45.90% of participants reporting moderate to severe depression (scores greater than 10), and 37.99% of participants reporting moderate to severe anxiety (scores greater than 10).

Analyses

Node Selection. We were interested in the relationship between internalizing symptoms and aspects of social support. We therefore drew a bank of items using scales that measured internalizing symptoms (PHQ-8, GAD-7) and social support (MSSS). However, such psychometric scales are often not created with a complexity perspective in mind and are often designed to measure a common underlying factor or factor structure (McNally, 2016). Therefore, we performed several tests to ensure that the items we selected were suitable for network

analyses. First, we used the *goldbricker* procedure in the *networktools* package (Jones, 2018) to identify problematic topological overlap. Topological overlap occurs when two items measure the same underlying construct. The *goldbricker* procedure attempts to measure the degree of topological overlap by examining how items (1) correlate with one another and (2) show differential associations with other items in the dataset. When items are highly correlated and do not show differential associations, they can be removed from the dataset or combined with one another via principal components analysis (PCA; e.g., Levinson et al. 2018). For this study, we combined any overlapping items using PCA.

In addition to measuring topological overlap, we also wanted to ensure that the PHQ-8 and GAD-7 clustered together in such a way that they could plausibly be both considered part of an "internalizing" cluster, as in past network analyses (e.g., Anket et al., 2017). We generated a network of the PHQ-8 and GAD-7 items using a graphical LASSO approach and conducted community analyses using a walktrap approach (four, eight, or twenty steps) and using a spinglass algorithm.

Within-Cluster Centrality. First, we were interested in measuring the centrality of items within the internalizing cluster. We computed networks using a graphical LASSO approach (gamma = 0.5) using the bootnet package (Epskamp et al., 2018). After the network was computed, we then sub-selected the internalizing nodes and performed centrality analyses within that cluster. We used expected influence centrality (Robinaugh, Millner, & McNally, 2016). Expected influence measures the sum of edge weights, whether positive or negative, extending from a node. In this case, we measured the sum of edge weights extending from a node to other nodes within the internalizing cluster. Expected influence is related to strength centrality, which measures the sum of the *absolute value* of edge weights extending from a node. However,

expected influence is of greater relevance in psychopathology networks, where the activation or deactivation of nodes (e.g., positive or negative relationships) is meaningful. When negative edges are not present, expected influence is equivalent to strength centrality. Finally, it is important to note that, although the term refers to "influence," analyses of expected influence do not necessarily imply causality. We also measured the expected influence of items within the social support cluster.

Across-Cluster (Bridge) Centrality. Several studies have assessed the centrality of items within depression symptom networks (e.g., Beard et al., 2016; Bos et al., 2018) and internalizing symptom networks (e.g., Anker et al., 2017; McElroy & Patalay, 2019). However, we are only aware of one study (Jayawickreme et al., 2017) that examines the cross-cluster relationships between symptoms of internalizing and social problems. No network analysis studies have examined the relationships between internalizing symptoms and positive aspects of social support. We assessed the cross-cluster relationships by using bridge expected influence (Jones, Ma, & McNally, 2018), which takes the sum of edges connecting a node to clusters other than its own. In this case, bridge expected influence measures the degree to which a social support node is connected to internalizing symptoms, or vice versa. Bridge expected influence can be either positive or negative. A large positive bridge expected influence would suggest that a social support node is associated with increases in internalizing, whereas a large negative bridge expected influence would suggest that a social support node is associated with decreases in internalizing. Because there are different numbers of nodes in each cluster, we further normalized bridge expected influence such that it was comparable across clusters.

Validity of Centrality Measures. Recent debate has called into question the validity and utility of some centrality measures. Specifically, the utility of betweenness centrality and

closeness centrality has been questioned, due to assumptions regarding information transfer that are potentially violated within psychometric network analyses. The validity of interpreting strength centrality or expected influence centrality in terms of clinical priorities has been questioned as well (Rodebaugh et al., 2018).

Some empirical evidence suggests that centrality values do hold convergent validity with clinical outcomes (Elliott, Jones, & Schmidt, 2018), whereas other empirical evidence is contradictory or mixed (Rodebaugh et al., 2018). Even if centrality nodes predict clinical outcomes, they may not be malleable via psychological or medical treatments, calling into question their utility for treatment practitioners. Despite this, centrality values may yet be useful to scientists and nosologists as they give information regarding the empirical structure of sets of symptoms. Expected influence centrality in particular was designed for and is highly relevant to psychopathology networks and may yield important insights regarding the structure of psychopathology (Robinaugh et al., 2016).

Stability. We conducted stability analyses for the entire network and for each type of centrality measure using the *bootnet* package (Epskamp et al., 2018). We used nonparametric and case-dropping bootstrapping, testing the stability of each edge as well as testing the stability of centrality estimates. Using the case-dropping bootstrap, we computed a centrality-stability (CS) coefficient for the centrality values. The CS coefficient broadly indicates the reliability of the estimates, with benchmarks set at 0.25 for adequate stability and 0.5 for good stability (Epskamp et al., 2018). The CS coefficient is calculated by gradually dropping participants from the sample and determining what proportion of the sample can be dropped before the correlation between the original centrality values and the dropped-sample centrality values falls below 0.75.

Thus, a CS coefficient of 0.25 indicates that 25% of the sample can be dropped before centrality estimates become unreliable.

Results

Node selection. The goldbricker algorithm determined that there was a high degree of topological overlap between items from each subscale of the MSSS. Thus, for each subscale, we combined all four items into a single item using principal components analysis. In addition, two items within the GAD-7 ("Worrying too much about different things", "Not being able to stop or control worrying") and two items within the PHQ-8 ("Feeling bad about yourself, or that you are a failure, or have let yourself or your family down", "Feeling down, depressed, or hopeless") showed a high degree of topological overlap, and were also combined with principal components analysis. Combining items with principal components analysis increases their variance, and variance differences can lead to artificially inflated connectivity values (Terluin, de Boer, & de Vet, 2016). Therefore, we rescaled each combined item to original Likert scale values to make variances comparable across items.

Using a walktrap algorithm (four, eight, or twenty steps), the community analysis indicated that the internalizing items formed a single cluster. Using a spinglass algorithm, the items were divided into communities, but were not reliably separated by GAD and PHQ status – instead, items from each scale were mixed across clusters. Given these results, we did not separate our analyses by GAD and PHQ, but instead combined both sets of items into a single internalizing cluster.

Within-Cluster Centrality. Within the internalizing cluster, *worry*, *nervous*, and *downself* exhibited high expected influence values on internalizing symptoms (see Figure 1 for internalizing cluster expected influence values). The expected influence of these nodes was

reliably distinguishable from several of the less central items (e.g., *sleep*, *tired*, *motor*), as determined by the stability analyses (Figure S1 for expected influence differences). Within the social support community, *friends* was the most central item, and was distinguishable from both *significant other* (*SO)* and *family* (see Figure S2 and S3 in supplemental materials for expected influence difference tests and confidence intervals). Examining the network, it is apparent that this centrality pattern can be explained by the fact that a strong relationship exists between having friendship support and family support, and a strong relationship exists between having friendship support and significant other support, but the relationship between family support and significant other support is somewhat weaker.

Across-Cluster (Bridge) Centrality. Normalized bridge expected influence values for the network of internalizing symptoms and social support are presented in Figure 2A, alongside the network of internalizing symptoms and social support (Figure 2B). Because normalization is done separately from bootstrapping, confidence intervals are not displayed in Figure 2, but are visible in the non-normalized version in supplemental Figure S4. Across the two clusters, several nodes showed notable bridge expected influence values. For expected influence differences, see Figure S5. Across all nodes, bridge expected influence was negative, indicating that having higher levels of social support was associated with lower levels of internalizing symptoms and vice versa. After normalization across clusters, *downself* clearly appeared to be an important bridge node from the internalizing cluster. This relationship is correlational, meaning that it cannot be determined whether *downself* negatively impacts social support, that social support mitigates *downself*, or both. *Family, friends,* and *SO* were each negatively connected to internalizing symptoms, indicating that having poorer support in general was associated with higher levels of symptoms. Although *family* had a larger point estimate in terms of strength of

connection, the bootstrapped difference test did not show a difference between the bridge expected influence values of *family*, *friends*, and *SO*.

Stability. Overall, stability estimates for the network were adequate for interpretation. Confidence intervals surrounding edges and centrality estimates were of moderate size, indicating that cautious interpretations can reasonably be made. Results from the case-dropping bootstraps indicated that stability ranged from acceptable to good. Expected influence values within the internalizing cluster and within the social support cluster were good (*CS* = 0.594, *0.594*). Bridge expected influence values across clusters were in the acceptable range (*CS* = 0.439). Centrality stability coefficients mean that between 44-59% of the sample could be reasonably dropped before centrality estimates begin to become unreliable. Bootstrapped difference tests were used to guide interpretations of centrality and are available in the supplementary materials.

Discussion

This study uses network analysis to better understand the relationships between social support and symptoms of anxiety and depression in Kenyan high school students. Specifically, this study identifies the most central internalizing psychopathology nodes, then identifies the most central social support nodes. Finally, this study identifies factors and symptoms that most strongly link social support to internalizing symptoms of depression and anxiety.

Within the internalizing cluster, *worry* (two topologically overlapping items within the GAD-7: "Worrying too much about different things" and "Not being able to stop or control worrying"), *nervous* (GAD-7 item 1: “Feeling nervous, anxious, or on edge”), and *downself* (a combination of two topologically overlapping items within the PHQ-8: "Feeling bad about yourself, or that you are a failure, or have let yourself or your family down" and "Feeling down, depressed, or

hopeless") exhibited significantly greater centrality than other items within the network. This may mean that worry, nervousness, and feeling down (especially about oneself) are especially important in internalizing psychopathology.

This finding aligns with some past research. First, past research supports the fact that Kenyan high school students experience great pressure to succeed, and experience enormous social and vocational consequences if they do not (Gitome et al., 2013). This may align with the finding that feeling down, hopeless, and like you have let your family down is a particularly important internalizing symptom. Additionally, one past study of a depression and anxiety symptom network (Beard et al., 2016), found that worry and sad mood (related to *downself*, which encompasses both sad mood and feeling like a failure) were highly central symptoms. Additionally, one past network analysis examined a network of anxiety symptoms, depressive symptoms, and PTSD symptoms (Frewen, Schmittmann, Bringmann, and Borsboom, 2013). This analysis also found that worry and depressed mood were highly central symptoms. Finally, past literature reviews have found that both depression and anxiety often involve rumination, which is similar to worry (Garber & Weersing, 2010). Notably, this is the first study the authors know of to find that nervousness is a central symptom in a network of symptoms of anxiety and depression. Nervousness many be uniquely central in this sample, perhaps because many of the adolescents in this study were living under highly stressful conditions. Future research should replicate this finding and compare across low-income and higher-income samples. These findings may be clinically useful in preventing the development and worsening of comorbid anxiety and depression. For example, clinicians working with clients with or at risk for comorbid anxiety and depression might target these symptoms in order to reduce symptoms of both disorders.

Within the social support network, *friends*, a combination of four items about social support from friends, was the most central node, differing significantly from the other nodes in its expected influence. Interestingly, social support from friends is strongly connected to both family support and significant other support, yet family support and significant other support were not as strongly connected to each other. No past studies have created a network of different sources of social support, so we cannot compare this finding to past research. Nonetheless, the finding of this present study may suggest that perceived relationships with friends are most influential for overall perceived social support. In the context of Kenyan adolescents, this may be the case because many students live in single-sex boarding schools, and therefore have little contact with their parents and little opportunity to interact with potential romantic significant others. Additionally, such relationships are actively discouraged and prevented in many high schools.

Across the internalizing cluster and the social support cluster, bridge expected influence values were negative, showing that having greater social support is associated with having lower internalizing symptoms and vice versa. This aligns with past research showing inverse associations between positive social support and internalizing symptoms and showing positive associations between negative social interactions and internalizing symptoms (e.g., Kessler et al., 1985). More specifically, *downself* was an important bridge node between social support and the internalizing cluster, meaning that feeling down may negatively impact social support and vice versa.

Finally, an analysis of the relationships between the social support and internalizing symptom nodes showed that the social support nodes for *family*, *friends,* and *SO* were each negatively connected with the internalizing symptoms cluster, indicating that having poorer

support across all these domains was associated with greater internalizing symptoms. There was no significant difference in their strength of influence. This is somewhat surprising given that much of this sample lived in single-sex boarding schools and therefore had little opportunity for contact with family or potential significant others.

These findings may be clinically useful, despite their cross-sectional nature. Of course, given the cross-sectional nature of the data, we cannot be sure whether changes in social support cause changes in internalizing symptoms, changes in internalizing symptoms cause changes in social support, or changes in some third variable cause changes in both. If changes in social support cause changes in internalizing symptoms, then the findings of this study may indicate that intervening on any kind of social support may protect against internalizing symptoms. Additionally, certain symptoms may be most connected to certain kinds of social support, a finding which may also carry clinical utility. For example, *friends* is most negatively associated with *downself*, perhaps indicating that patients who feel down and like a failure would benefit from greater social support from friends. More broadly, targeting forms of social support that are most connected to certain symptoms may help to efficiently relieve these symptoms. Especially when done on an individual patient level, targeting specific symptoms and protective factors such as social support may prove clinically useful.

This study has several limitations. First of all, as in most network analyses, the findings are exploratory – the researchers did not have a particular a priori hypothesis in mind they aimed to test. Relatedly, the measures used in this analysis may be missing certain symptoms of anxiety and depression or aspects of social support, which can lead to incorrect or incomplete conclusions (Jones, Heeren, & McNally, 2017). Additionally, the data are cross-sectional, and therefore only allow for analyses of contemporaneous associations and not causal relationships.

Finally, our sample was taken from the general population of Kenyan high school students, and therefore our findings may not generalize to clinical samples.

Nonetheless, this study suggests several possible future directions. First of all, these findings should be replicated in future studies to confirm the structure of internalizing and social support networks in Kenyan adolescents. This study, in combination with future research, will allow us to better understand the relationships between specific internalizing symptoms and specific aspects of social support. Internalizing symptoms have been shown to be correlated with lower social support (e.g., Gaylord-Harden, Rahsdale, Mandara, Richards, & Petersen, 2007), but the specific nature of that connection is not well understood, especially on the symptom level, and especially in Kenyan adolescents.

Additionally, future research should aim to understand cross-cultural differences in the relationships between specific aspects of internalizing symptoms and social support. Therefore, the findings of this current study should be compared to the internalizing symptom and social support networks of other populations. Doing so will allow researchers to understand differences in the relationships between internalizing symptoms and social support across cultures and individuals.

Studies such as this present study may also help identify targets for prevention and intervention. For example, the most central symptoms may help determine the most effective targets for intervention. In the case of this current study, these may be worry, nervousness, and feelings of sadness and personal failure. Additionally, identifying links between internalizing symptoms and malleable risk and protective factors such as social support may help identify effective targets for prevention and intervention. In order to increase social support in Kenyan adolescents, for example, it may be particularly important to target relationships with friends and

doing so might help protect against symptoms of anxiety and depression. Relatedly, symptom networks could be useful on an individual patient level. For example, a clinician could use a network analysis of a patient's symptoms to better understand which symptoms are most central for that patient and intervene on those most central symptoms.

Conclusion

This present study presents a network analysis of internalizing symptoms and social support in adolescents. We found that internalizing symptoms clustered together, and that social support from friends, family, and significant others were all negatively associated with symptoms of anxiety and depression in this population. Network analyses such as this study may help us to better understand comorbidity, understand the relationships between specific symptoms and risk and protective factors, and better understand cross-cultural differences in psychopathology.

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA.

Anker, J., Forbes, M., Almquist, Z., Menk, J., Thuras, P., Unruh, A., & Kushner, M. (2017). A Network Approach to Modeling Comorbid Internalizing and Alcohol Use Disorders. *Journal of Abnormal Psychology*, 126(3), 325-339.

Armour, Fried, Deserno, Tsai, & Pietrzak. (2017). A network analysis of DSM-5 posttraumatic stress disorder symptoms and correlates in U.S. military veterans. *Journal of Anxiety Disorders*, 45(C), 49-59.

Beard, C., Millner, A. J., Forgeard, M. J. C., Fried, E. I., Hsu, K. J., Treadway, M. T., . . . Björgvinsson, T. (2016). Network analysis of depression and anxiety symptom relationships in a psychiatric sample. *Psychological Medicine*, *46*(16), 3359-3369.

Bele, S. D., Bodhare, T. N., Valsangkar, S., & Saraf, A. (2013). An epidemiological study of emotional and behavioral disorders among children in an urban slum. *Psychology, health & medicine*, *18*(2), 223-232.

Bos, F., Fried, M., Hollon, E., Bringmann, I., Dimidjian, S., DeRubeis, D., & Bockting, L. (2018). Cross-sectional networks of depressive symptoms before and after antidepressant medication treatment. *Social Psychiatry and Psychiatric Epidemiology, 53*(6), 617-627.

Borsboom, D., & Cramer, A. O. J. (2013). Network analysis: An integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology*, 9, 91-121.

Boschloo, L., Schoevers, R., Van Borkulo, C., Borsboom, D., & Oldehinkel, A. (2016). The Network Structure of Psychopathology in a Community Sample of Preadolescents.

Journal of Abnormal Psychology, 125(4), 599-606.

Cheng, L., Lou, S., Kalamar, J., . . . Ojengbede. (2014). The Association Between Social Support and Mental Health Among Vulnerable Adolescents in Five Cities: Findings from the Study of the Well-Being of Adolescents in Vulnerable Environments. *Journal of Adolescent Health*, 55(6), S31-S38.

Coker, A. L., Smith, P. H., Thompson, M. P., Mckeown, R. E., Bethea, L., & Davis, K. E. (2002). Social Support Protects against the Negative Effects of Partner Violence on Mental Health. *Journal of Womens Health & Gender-Based Medicine, 11*(5), 465-476.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and Development of Psychiatric Disorders in Childhood and Adolescence. *Archives of General Psychiatry, 60*(8), 837.

Dashiff, C., DiMicco, W., Myers, B., Sheppard, K. (2009). Poverty and Adolescent Mental Health. *Journal of Child and Adolescent Psychiatric Nursing 22*, 23–32.

Elliott, H., Jones, P. J., & Schmidt, U. (2018, November 13). Central Symptoms Predict Post-Treatment Outcomes and Clinical Impairment in Anorexia Nervosa: A Network Analysis in a Randomized-Controlled Trial. https://doi.org/10.31234/osf.io/hw2dz

Epskamp, S., Borsboom, D., & Fried, E. I. (2017). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, 50(1), 195-212.

Epskamp, S., (2018). Package 'bootnet': Bootstrap Methods for Various Network Estimation Routines.

Ernst, K. C., & Phillips, B. S. (2013). Slums are not places for children to live: vulnerabilities, health outcomes, and possible interventions. *Advances in pediatrics*, *60*(1), 53-87.

Fergusson, D. M., Horwood, L. J., Ridder, E. M., & Beautrais, A. L. (2005). Suicidal behaviour

in adolescence and subsequent mental health outcomes in young adulthood. *Psychological Medicine, 35*(7), 983-993.

Fisher, A., Reeves, J., Lawyer, G., Medaglia, J., & Rubel, J. (2017). Exploring the Idiographic Dynamics of Mood and Anxiety via Network Analysis. *Journal of Abnormal Psychology*, 126(8), 1044-1056.

Fried, Epskamp, Nesse, Tuerlinckx, & Borsboom. (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.

Fried, E. I., & Nesse, R. M. (2014). The impact of individual depressive symptoms on impairment of psychosocial functioning. *Plos One*, 9(2), e90311.

Fried, E. I., & Nesse, R. M. (2015). Depression is not a consistent syndrome: An investigation of unique symptom patterns in the STAR*D study. *Journal of Affective Disorders*, 172, 96 –102.

Fried, E. I., van Borkulo, C. D., Cramer, A. O. J., Boschloo, L., Schoevers, R. A., & Borsboom, D. (2017). Mental disorders as networks of problems: A review of recent insights. *Social Psychiatry and Psychiatric Epidemiology*, 52(1), 1-10.

Garber, J., & Weersing, V. R. (2010). Comorbidity of Anxiety and Depression in Youth: Implications for Treatment and Prevention. *Clinical Psychology: Science and Practice, 17*(4), 293-306.

Gitome, J.W., Katola, M.T., Nyabwari, B.G. (2013) Correlation between students' discipline and performance in the Kenya certificate of secondary education. *International Journal of Education and Research, 1*(8), 1-10.

Goodman, Sherryl H., Matthew H. Rouse, Arin M. Connell, Michelle Robbins Broth, Christine M. Hall, and Devin Heyward. "Maternal depression and child psychopathology: A meta-analytic review." *Clinical child and family psychology review* 14, no. 1 (2011): 1-27.

Haag, C., Robinaugh, D. J., Ehlers, A., & Kleim, B. (2017). Understanding the emergence of chronic posttraumatic stress disorder through acute stress symptom networks. *JAMA psychiatry*, *74*(6), 649-650.

Heeren, A., Jones, P. J., & McNally, R. J. (2018). Mapping network connectivity among symptoms of social anxiety and comorbid depression in people with social anxiety disorder. *Journal of Affective Disorders*, *228*, 75-82.

Himle, J. A., Baser, R. E., Taylor, R. J., Campbell, R. D., & Jackson, J. S. (2009). Anxiety disorders among African Americans, blacks of Caribbean descent, and non-Hispanic whites in the United States. *Journal of Anxiety Disorders*, *23*(5), 578-590.

Insel, T. R. (2014). The NIMH research domain criteria (RDoC) project: Precision medicine for psychiatry. American Journal of Psychiatry, 171 (4), 395–397.

Jayawickreme, N., Mootoo, C., Fountain, C., Rasmussen, A., Jayawickreme, E., & Bertuccio, R.F. (2017). Post-conflict struggles as networks of problems: A network analysis of trauma, daily stressors and psychological distress among Sri Lankan war survivors. *Social Science & Medicine*, 190, 119-132.

Jones, P. J. (2018). networktools: Tools for identifying important nodes in networks. *R package version 1.2.0.* Retrieved form https://CRAN. R-project. org/package= networktools.

Jones, P. J., Ma, R., & McNally, R. J. (2018). Bridge centrality: A network approach to understanding comorbidity. *Multivariate Behavioral Research*, 1-15.

Jones, P. J., Mair, P., Riemann, B. C., Mugno, B. L., & McNally, R.J. (2018). A network perspective on comorbid depression in adolescents with obsessive-compulsive disorder. *Journal of Anxiety Disorders*, 53, 1-8.

Keller, M., Neale, M., & Kendler, K. (2007). Association of Different Adverse Life Events with Distinct Patterns of Depressive Symptoms. *American Journal of Psychiatry*, 164(10), 1521-1529.

Kessler, R., Price, R., & Wortman, C. (1985). Social Factors in Psychopathology: Stress, Social Support, and Coping Processes. *Annual Review of Psychology*, 36, 531-572.

Kovacs, M. (1992). Children's depression inventory: manual. Multi-Health Systems.

Kieling, Baker-Henningham, Belfer, Conti, Ertem, Omigbodun, . . . Rahman. (2011). Child and adolescent mental health worldwide: Evidence for action. *The Lancet*, 378(9801), 1515-1525.

Kiernan, K. E., & Mensah, F. K. (2009). Poverty, maternal depression, family status and children's cognitive and behavioural development in early childhood: A longitudinal study. *Journal of Social Policy*, *38*(4), 569-588.

King, N. J., & Bernstein, G. A. (2001). School Refusal in Children and Adolescents: A Review of the Past 10 Years. *Journal of the American Academy of Child & Adolescent Psychiatry, 40*(2), 197-205.

Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals*, *32*(9), 509–515.

Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. B. W., Berry, J. T., & Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal*

of Affective Disorders, *114*(1–3), 163–173.

Langer, J. K., Tonge, N. A., Piccirillo, M. L., Rodebaugh, T. L., Thompson, R. J., & Gotlib, I. H. (2019). Symptoms of social anxiety disorder and major depressive disorder: A network perspective. *Journal of Affective Disorders*, 243, 531-538.

Levinson, C. A., Brosof, L. C., Vanzhula, I., Christian, C., Jones, P., Rodebaugh, T. L., . . . & Fernandez, K.C. (2018). Social anxiety and eating disorder comorbidity and underlying vulnerabilities: Using network analysis to conceptualize comorbidity. *International Journal of Eating Disorders*, 51(7), 693-709.

McElroy, E., Fearon, P., Belsky, J., Fonagy, P., & Patalay, P. (2018). Networks of depression and anxiety symptoms across development. *Journal of the American Academy of Child and Adolescent Psychiatry*.

Mcelroy, E., & Patalay, P. (2019). In search of disorders: Internalizing symptom networks in a large clinical sample. Journal of Child Psychology and Psychiatry. (In press).

McNally, R. (2016). Can network analysis transform psychopathology? *Behaviour Research and Therapy*, *86*, 95-104.

McNally, R.J., Mair, P., Mugno, B.L., & Riemann, B.C. (2017). Co-morbid obsessive–compulsive disorder and depression: A Bayesian network approach. *Psychological Medicine*, 47(7), 1204-1214.

Mullarkey, M., Marchetti, I., & Beevers, C. (2018). Using Network Analysis to Identify Central Symptoms of Adolescent Depression. *Journal of Clinical Child & Adolescent Psychology*, 1-13.

Ndetei D.M., Khasakhala L., Nyabola L., et al. (2008). The prevalence of anxiety and depression symptoms and syndromes in Kenyan children and adolescents. *Journal of Child &*

Adolescent Mental Health 20, 33–51.

Newman, B.M., Newman, P.R., Griffen, S., O'Connor, K., & Spas, J. (2007). The relationship of social support to depressive symptoms during the transition to high school. *Adolescence,* 42(167), 441-459.

Omoro, S. A. O., Fann, J. R., Weymuller, E. A., MacHaria, I. M., & Yueh, B. (2006). Swahili translation and validation of the Patient Health Questionnaire-9 depression scale in the Kenyan head and neck cancer patient population. *The International Journal of Psychiatry in Medicine, 36*(3), 367–381.

Osborn, T., Venturo-Conerly, K., Wasil, A., Schleider, J., & Weisz, J. (2019). *Depression and Anxiety Symptoms, Social Support, and Demographic Factors Among Kenyan High School Students.* DOI: 10.31234/osf.io/q5s63

Osborn, T., Wasil, A., Venturo-Conerly, K., Schleider, J., & Weisz, J. (2019). *Group Intervention for Adolescent Anxiety and Depression: Outcomes of a Randomized Trial with Adolescents in Kenya*. DOI: 10.31234/osf.io/qp4ev

Philias O.Y. & Wanjobi W.C. (2011). Performance Determinants of Kenya Certificate of Secondary Education (KCSE) in Mathematics of Secondary Schools in Nyamaiya Division, Kenya. *Asian Social Science 7*, 107–112.

Robinaugh, D. J., Millner, A. J., & McNally, R. J. (2016). Identifying highly influential nodes in the complicated grief network. *Journal of Abnormal Psychology*, 125(6), 747-757.

Rodebaugh, T. L., Tonge, N. A., Piccirillo, M. L., Fried, E., Horenstein, A., Morrison, A. S., . . . Heimberg, R. G. (2018). Does centrality in a cross-sectional network suggest intervention targets for social anxiety disorder? *Journal of Consulting and Clinical Psychology, 86*(10), 831-844.

Rook, G. A., Raison, C. L., & Lowry, C. A. (2018). Childhood Microbial Experience, Immunoregulation, Inflammation, and Adult Susceptibility to Psychosocial Stressors and Depression. *Inflammation and Immunity in Depression*, 17-44.

Rosario, M., Salzinger, S., Feldman, R. S., & Ng-Mak, D. S. (2007). Intervening Processes Between Youths' Exposure to Community Violence and Internalizing Symptoms Over Time: The Roles of Social Support and Coping. *American Journal of Community Psychology, 41*(1-2), 43-62.

Sarason, Irwin G., Sarason, Barbara R., Potter, Earl H., & Antoni, Michael H. (1985). Life Events, Social Support, and Illness. Psychosomatic Medicine, 47(2), 156-163.

Semrau, Maya, Evans-Lacko, Sara, Alem, Atalay, Ayuso-Mateos, Jose Luis, Chisholm, Dan, Gureje, Oye, . . . Thornicroft, Graham. (2015). Strengthening mental health systems in low- and middle-income countries: The Emerald programme. *BMC Medicine*, 13(1), 79.

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.

Terluin, Berend, De Boer, Michiel R., & De Vet, Henrica C. W. (2016). Differences in Connection Strength between Mental Symptoms Might Be Explained by Differences in Variance: Reanalysis of Network Data Did Not Confirm Staging. *PLoS ONE*, 11(11),

E0155205.

Wasil, A., Venturo-Conerly, K., Shinde, S., Patel, V., & Jones, P. J. (2019, April 8). Applying Network Analysis to Understand Depression and Substance Use in Indian Adolescents. https://doi.org/10.31234/osf.io/hk5e3

Weersing, V. R., Gonzalez, A., Campo, J. V., & Lucas, A. N. (2008). Brief Behavioral Therapy for Pediatric Anxiety and Depression: Piloting an Integrated Treatment Approach. *Cognitive and Behavioral Practice, 15*(2), 126-139.

Wright, D.R., Katon, W.J., Ludman, E., McCauley, E., Oliver, M., Lindenbaum, J., & Richardson, L. P. (2016). Association of adolescent depressive symptoms with health care utilization and payer-incurred expenditures. Academic Pediatrics, 16(1), 82–89.

Kenya National Bureau of Statistics. (2009). *2009 Kenya Housing and Population Census*.

Kessler, R. (1985). Social Factors in Psychopathology: Stress, Social Support, and Coping Processes. *Annual Review of Psychology*, *36*(1), 531-572.

Patel, V., Flisher, A.J., Hetrick, S. & McGorry, P. (2007). Mental health of young people: A global public-health challenge. *The Lancet*, 369(9569), 1302-1313.

Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The multidimensional scale of perceived social support. *Journal of Personality Assessment*, *52*(1), 30–41.

Figure 1: Internalizing Symptom Expected Influence in Relation to Total Internalizing

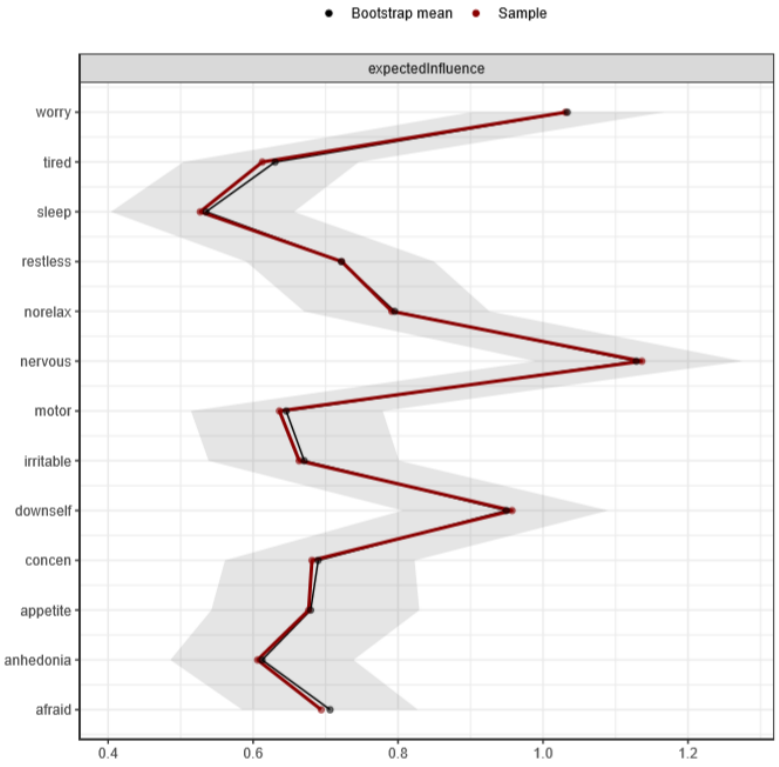

Figure 1 Caption: Figure 1 illustrates the centrality (expected influence) of each internalizing symptom in the internalizing network. Nervousness, worry, and feeling down were the most central symptoms in the network.

Figure 2: Internalizing Symptom & Social Support Normalized Expected Influence & Network

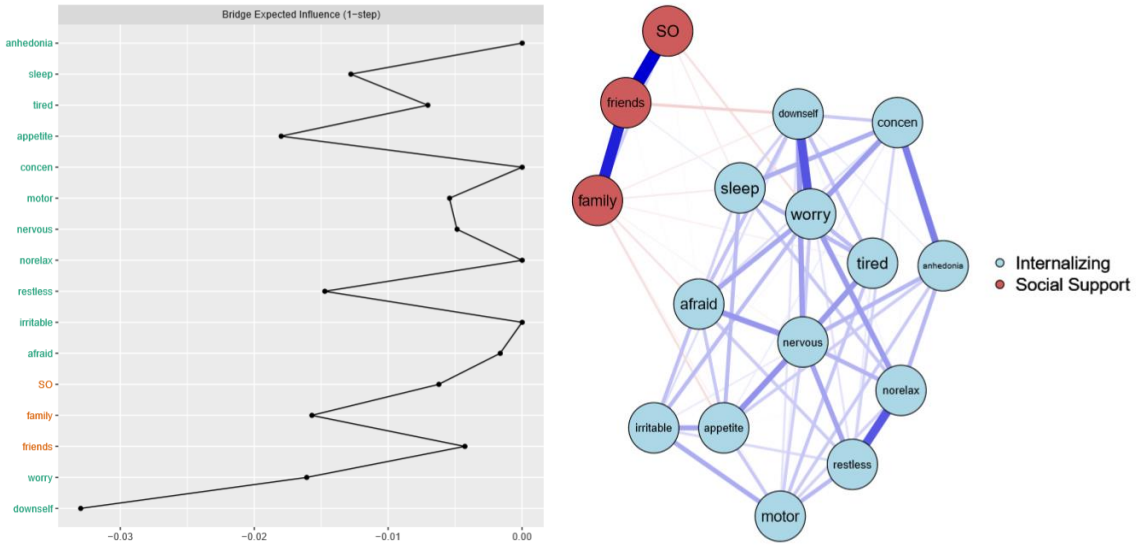

Figure 2 Caption: Figure 2A (left) illustrates the bridge centrality (bridge expected influence between internalizing and social support symptoms) of each internalizing symptom and aspect of social support in the internalizing and social support network. Feeling down demonstrated particularly high bridge expected influence. Figure 2B (right) shows the network of internalizing symptoms and social support. Blue lines indicate positive partial correlations and red lines indicate negative partial correlations; Line thickness indicates the magnitude of partial correlations.