A network approach to female sexual function: Comparison of symptom networks of women with high, moderate and low levels of sexual distress

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Title: A network approach to female sexual function: Comparison of symptom networks of women with high, moderate and low levels of sexual distress
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Abstract: Background: Female sexual function (FSF) is not well understood and issues relating to female sexual dysfunction (FSD) are a prevalent concern among women around the world. The role of sexual distress has been a central question in the FSD research field, but it remains unclear why sexual functioning problems are distressing to some, but not all, women. In the present study a new research method, in the form of a network analysis, was used to investigate the connection between sexual distress and female sexual function. Methods: Three between-subject networks for women reporting high, moderate and low levels of sexual distress were estimated and analyzed. The symptom networks consisted of variables on female sexual function as well as other relevant correlates such as childhood maltreatment, psychological distress, body dissatisfaction, sociosexual orientation and alcohol use. The data from a population-based sample of 3,144 Finnish women was used. Results: The three networks were for the most part similar with each other. No significant differences were observed between the different distress networks. Arousal, emotional abuse and lubrication were the most central variables. The networks showed differences in network fragmentation. The high group showed less fragmentation than the other two networks, implying that the high group had a more vulnerable network structure. Conclusions: As far as we know this is one of the first studies to explore the role of sexual distress on the complex symptom interactions between identified correlates, such as female sexual function, psychological distress, childhood maltreatment and alcohol use. Future research should aim to investigate the effect of relationship factors on female sexual function and sexual distress.
Keywords: Female sexual function, female sexual dysfuntion, sexual distress, network analysis
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Avhandlingens titel: Nätverksanalys av kvinnors sexuella funktionsförmåga: Jämförelse av symptomnätverk hos kvinnor med hög, moderat och låg nivå av sexuell ångest
Handledare: Marianne Källström and Patrick Jern
Abstrakt: Bakgrund: Kvinnors sexuella funktionsförmåga är inte tillräckligt undersökt och problem relaterade till kvinnlig sexuell dysfunktion är prevalenta problem för kvinnor runt världen. Sexuell ångest och dess betydelse har varit en central forskningsfråga inom sexualforskning men det är fortfarande oklart varför vissa kvinnor utvecklar sexuell ångest samtidigt med funktionsproblem och varför vissa kvinnor inte gör det. Syftet med den här studien var att utnyttja en ny forskningsmetod, i form av en nätverksanalys, för att undersöka symptomnätverk med varierande nivåer av sexuell ångest. Jag ville undersöka och jämföra dessa nätverk för att utvidga förståelsen av associationerna mellan sexuell ångest och kvinnors sexuella funktionsförmåga. Metoder: Jag estimerade och analyserade tre mellanindividnätverk för kvinnor som rapporterade hög, moderat och låg nivå av sexuell ångest. Symptomnätverken bestod av mått på kvinnors sexuella funktionsförmåga och andra identifierade korrelat, som barndomstrauma, dysfunktionellt ätbeteende, depression, ångest, kroppsmissnöje, sociosexualitet och alkoholkonsumtion. Ett populationsbaserat sampel som bestod av 3 144 finska kvinnor mellan 18 och 49 år användes. Nätverken estimerades, analyserades och visualiserades med R-paket utvecklade för nätverksanalys. Resultat: De tre nätverken var till största delen lika varandra och det observerades inga signifikanta skillnader mellan dem. Sexuell upphetsning, känslomässiga övergrepp (eng. emotional abuse) och lubrikation var de mest centrala noderna i nätverken. Nätverken skilde sig angående nätverksfragmentering. Det höga nätverket uppvisade mindre fragmentering än de två andra nätverken, vilket tyder på att det höga nätverket hade en mer sårbar nätverksstruktur. Sammanfattning: Studien är bland de första studierna som har undersökt rollen av sexuell ångest i diverse symptominteraktioner på kvinnors sexuella funktionsförmåga och identifierade korrelat, som psykisk hälsa, barndomstrauma och alkoholkonsumtion. Framtida studier borde undersöka effekten av relationsfaktorer på kvinnors sexuella funktionsförmåga och sexuell ångest.
Nyckelord: Kvinnors sexuella funktionsförmåga, kvinnors sexuella dysfunktioner, sexuell ångest, nätverksanalys

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Introduction

Sexuality and sexual functioning are important parts of life. Good sexual functioning has been linked with better overall health, relationship satisfaction (Witting et al., 2008) and quality of life (Laumann et al., 2006; Davison, Bell, LaChina, Holden, & Davis, 2009). Nevertheless, female sexual function (FSF) is still poorly understood and issues relating to female sexual dysfunction (FSD) are a prevalent and debilitating problem among many women (Burri, Rahman, & Spector, 2011; Shifren, Monz, Russo, Segreti, & Johannes, 2008; Witting et al., 2008). Additionally, the nature and progression of female sexual dysfunctions are unclear.

Firstly, a word on terminology is in order. FSF is a general term used to refer to aspects in the female sexual response cycle, such as desire, arousal, lubrication, orgasm, satisfaction and the absence of sexually related pain (Rosen et al., 2000). FSD, in turn, is a term with many connotations but is mainly used for diagnostic purposes, describing chronic problems occurring in the female sexual response cycle that cause explicit sexual distress. In the present study both terms will be used. FSF is used to describe non-clinical issues in female sexual function and FSD, conversely, is used in regard to diagnosed issues in female sexual function. One of the central issues in the research on FSDs has been to understand the relationship between FSF and sexual distress. Sexual distress refers to the experience of anxious or negative emotions towards one's own sexuality or sexual life (Derogatis, Rosen, Leiblum, Burnett, & Heiman, 2002; Meston & Trapnell, 2005). Sexual distress can occur concurrently with sexual function difficulties or independently: many studies have observed that all women with diminished levels of sexual function do not experience them as distressing (King, Holt, & Nazareth, 2007; Rosen et al., 2009; Stephenson & Meston, 2012). The reasons why sexual distress is not linearly related to sexual function are not known, but

several mediating factors have been identified (Stephenson & Meston, 2010; Stephenson, Hughan, & Meston, 2012; Stephenson & Meston, 2015; Witting et al., 2008). In terms of the diagnosis of female sexual dysfunctions (FSDs), the subjective experience of sexual distress is a central symptom and usually motivates seeking professional help. Without a subjective sense of distress, there might be no need for diagnosis or intervention. FSDs are prevalent and often occur co-morbidly (i.e., a person presents symptoms of more than one FSD) and they have been associated with other problems, such as reduced quality of life, and diminished mental and physical well-being (Naeinian, Shaeiri, & Hosseini, 2011; Nobre, Pinto-Gouveia, & Gomes, 2006; Polland, Davis, Zeymo, & Iglesia, 2019; Milhausen, Bucholz, Opperman, & Benson, 2015).

The aim of the present study was to apply new research methodology to examine the complex interplay between female sexual function, sexual distress and other associated risk factors. The network approach to psychopathology offers a new way to conceptualize psychopathology as networks of interacting individual symptoms, where different symptoms (i.e., study variables) are directly interacting with each other (Borsboom, 2017). In the present study, I compared between-subject symptom networks of women with different levels of sexual distress in an attempt to understand its association with female sexual function and known correlates of female sexual function, such as, childhood maltreatment, psychological distress (anxiety, depression), body dissatisfaction, alcohol use and sociosexual orientation.

Network Perspective on psychopathology

The network perspective on psychopathology conceptualizes mental disorders as dynamic symptom networks, where different symptoms are directly interacting with each other. It proposes that mental disorders result from direct causal relations between symptoms and that the symptoms are connected through multiples of biological, psychological and societal

mechanisms (Borsboom, 2017). In these networks, measured psychological symptoms and other variables (i.e., age or BMI) are called “nodes” in the network. Nodes are connected to each other by “edges”, which represent associations between symptoms. In between-subject networks edges are typically correlations or partial correlations (Epskamp & Fried, 2018; see Figure 1 for an illustration of a hypothetical network structure).

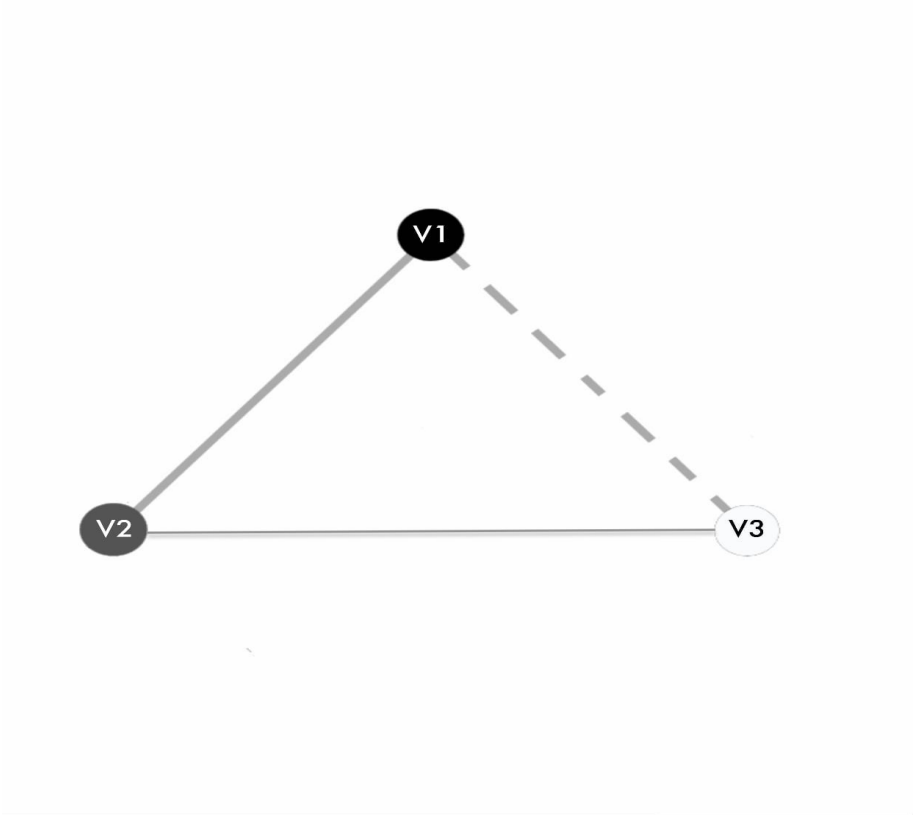


Figure 1. Example of a hypothetical network structure between three variabels (V1, V2 and V3). The variables are represented as nodes (circles) and the edges (lines) connecting them are representing partial correlations between the variables. Positive correlations are depicted as solid gray lines and negative correlations are depicted as dashed gray lines. The strength of the correlation is illustrated by the thickness of the lines. Therefore, the edge between V2 and V1 is stronger than the edge between V2 and V3.

For example, sexual arousal disorder can be conceptualized as the end state of interacting biological, psychological and social symptoms. Experiencing difficulties in becoming aroused during sexual activity could lead to increased preoccupation with

worrisome thoughts and shift the focus to nonsexual stimuli. This, in turn, might lead to increased internal distress which could further lead to a decline in sexual arousal and diminish motivation to continue with sexual activity. In this type of conceptualization, the symptoms form (negative) feedback loops with each other and the individual might enter a state where the connected symptoms continue to activate each other, and thereby sustaining the disordered state (van Borkulo et al., 2015: Borsboom, 2017).

The network model is often presented in contrast to the biomedical model of psychopathology, which rests on the assumption that there is a common causal factor for all observed symptoms. In the case of sexual arousal disorder, a biomedical frame of reference would hypothesize that a latent variable (e.g., a neurochemical imbalance or genetic abnormality) is the cause for all observed symptoms or issues (Borsboom & Cramer, 2013). The network model proposes that instead of a latent variable, it is the "activated" (i.e., feedback looping and thus self-sustaining) state of the symptom network that can be conceptualized as the disorder.

The nature and number of the associations between a network's nodes affect the overall structure of the network and this can vary from a stable weakly connected network (i.e., few weak negative associations) to a vulnerable strongly connected network (i.e., numerous strong negative associations). In a vulnerable strongly connected network, symptom activation can spread more easily (due to the presence of many strong associations between nodes measuring symptoms and pathological behavior) and cause the network to more easily develop into an activated feedback-looping state. Therefore, there is asymmetry in the dynamics of a vulnerable network. A triggering event or state can cause the activated state of a network, but the absence or ending of the triggering event or state does not lead to the deactivation of it. Stable weakly connected networks are more resilient to triggering events or states as the symptom activation in the network can not spread as easily (due to the

relative absence of strong negative associations between nodes) and therefore can not cause the network to become activated. Nodes with strong associations with each other have also a tendency to form node communities. This tendency is usually refered to as network fragmentation. Vulnerable networks show less fragmentations and form a fewer number of larger node communities. More resilient networks show more fragmentation and form numerous smaller node communities.

The network model further offers a new way to understand co-morbidity, which is frequently observed in psychiatric problems generally. It proposes that co-morbidity is a direct relationship between the symptoms of multiple disorders, instead of perceiving co-morbidity as a bidirectional correlation between two latent variables e.g., manifesting in an overlap in symptoms between depression and anxiety (Borsboom, Cramer, Schmittmann, Epskamp, & Waldorp, 2011). This way of describing co-morbidity could give insights to the etiology of FSDs, because co-morbidity between diagnostically different sexual dysfunctions is common (e.g., Witting et al., 2009), but not currently explained by any coherent theoretical framework. Additionally, female sexual function problems frequently occur co-morbidly with other psychopathologies, such as depression, anxiety and disordered eating (Yazdanpanahi, Nikkholgh, Akbarzadeh, & Pourahmad, 2015; Castellini et al., 2012). Another advantage of the network approach is that it aims to understand individual symptoms and their role in disorder progression.

Female sexual function and Female sexual dysfunction

Due to the idiosyncratic nature of sexuality and sexual functioning, large variation in sexual functioning issues and individual differences are customary. Lifestyle factors such as sexual experience and reproductive goals cause natural variation in sexual function. Therefore, consensus over definition and classification of FSDs have been limited and debate around them continue (Mimoun & Wylie, 2009; Basson et al., 2000). The International

Classification of Diseases -11 (ICD-11; World Health Organization, 2018) classifies female sexual dysfunctions into four categories; desire, arousal, orgasm and pain disorders and the 5th edition of the Diagnostic and Statistical Manual (DSM-5; American Psychiatric Association, 2013) into three; interest/arousal, orgasm and genito-pelvic pain/penetration disorders. Additionally, both diagnostic manuals require that the sexual function problems must have continued for several months (DSM-5 specifies this as at least 6 months) and have caused notable distress in order to receive a diagnosis of FSD. Despite the conceptual dissonance and debate, there is strong agreement that impaired FSF and FSDs are serious and prevalent public health issues that affect women all around the world (Witting, et al., 2008; McCool et al., 2016).

The overall and function specific prevalence rates for impaired FSF and FSD have varied markedly in prior studies due to different measurement tools, criteria and methodology (Hayes, Dennerstein, Bennet, & Fairley, 2008). In a recent meta-analysis by McCool and colleagues (2016), the overall prevalence for self-reported sexual functioning problems regardless of distress in premenopausal women was estimated to be 41%. Prevalence rates for specific function problems varied between 21-28% (desire disorder 28%, arousal 23%, lubrication 21%, orgasm 26% and pain 21%). The prevalence has been estimated to be higher in postmenopausal women, due to, for example, hormonal factors that affect sexual function (Nappi & Lachowsky, 2009; Hayes & Dennerstein, 2005). As for FSDs the reported prevalence rates have varied and according to several studies it is between 7-23% (Burri et al., 2011; Shifren et al., 2008; Witting et al., 2008).

The etiology of FSD has been identified to be multifactorial where biological, psychological and social factors all account for inter- and intra-individual variation. Twin studies have shown that the role of genes is secondary (additive and non-additive genetic effects vary between 3-18% depending on sexual domain) to that of the environment, as most

of the variation in FSF is explained by non-genetic differences (mostly environmental effects unique to the individual; see Witting et al., 2009; Burri, Greven, Leupin, Spector, & Rahman, 2012). Environmental factors such as age, psychological disorders, compatibility with partner, relationship satisfaction, pregnancy and alcohol consumption have all been found to be associated with FSF (Witting et al., 2009; Chen et al., 2013). Researchers have observed that women with FSDs experience significantly lower levels of physical and mental well-being and have a reduced quality of life when compared to unaffected women (Naeinian et al., 2011; Nobre, Pinto-Gouveia, & Gomes, 2006; Polland et al., 2019; Milhausen et al., 2015). Problems with depression and anxiety are also more common in women with FSDs (Laumann, Paik, & Rosen, 1999; Shifren et al., 2008). Atlantis and Sullivan (2012) conducted a longitudinal study and observed that depressed women had a 50% to 70% elevated risk to develop sexual functioning problems, and women with a sexual function problem had a 130% to 210% elevated risk of developing concomitant depression. Yazdanpanhani and colleagues (2015) observed a negative association between depression, anxiety and sexual function. Additionally, interpersonal factors such as relationship satisfaction and sexual compatibility with partner have also been identified to be associated with FSF (Witting et al., 2008). For example, a study reported that women who were dissatisfied with their relationship were more likely to report sexual functioning problems (Burri et al., 2011). Body dissatisfaction and disordered eating are additional phenomena that have been associated with issues in FSF and FSDs. For example, Castellini and colleagues (2012) observed that women with anorexic and/or bulimic symptoms had lower levels of sexual functioning. In a review conducted by Woertman and Van Den Brink (2012), it was observed that body image issues could affect all facets of sexual functioning negatively. Body dissatisfaction is largely associated with preoccupation with one's body weight and

shape, which can cause overt self-consciousness during sexual activity and diminish the satisfaction of sexual activity.

A few longitudinal studies have nevertheless been conducted. Gunst and colleagues (2017) conducted a longitudinal study investigating the temporal stability of FSF in two time points seven years apart. They observed that FSF varied considerably between the two time points, and surprisingly, that previously measured function was not a strong predictor of future function. Furthermore, relationship status (i.e., whether participants had remained in the same relationship, entered a new one, or become single over the course of the seven-year study period) was observed to predict temporal stability as well as cross-domain effects in FSF. For example, women in a relationship with the same partner at both time points reported decreased levels of desire, arousal, lubrication and satisfaction but had higher orgasm function at the later time point. Women with new partners also reported lower desire and arousal scores, but higher satisfaction and orgasm function at the later time point.

Additionally, many of the risk factors that are connected to FSDs are also connected to each other; depression and body dissatisfaction (Flores-Cornejo, Kamego-Tome, Zapata-Pachas, & Alvarado, 2017), depression and eating disorders (Manaf, Saravanan, Zuhrah, 2016), alcohol use and eating disorders (Bulik et al., 2004), childhood maltreatment and depression (Gerke et al., 2018) This makes it hard to disentangle the effects and associations these risk factors have with each other as well as FSDs. The network theory can be helpful in creating a more complex model were many relevant factors are included and can be controlled for.

Sexual distress

Sexual distress is generally defined as negative emotions or anxiety related to one's sexuality, sexual functioning or sexual life in general. It can also encompass feelings of dissatisfaction and bother relating to one's sexuality and sexual functioning (Witting et al., 2008; Derogatis

et al., 2002). Prevalence studies have estimated the overall prevalence rate of sexual distress in women, with or without impaired FSF, to be between 20% and 25% (Bancroft, Loftus, & Long, 2003; Shifren et al., 2008). In other words, approximately a quarter of women experience sexual distress regardless of their level of sexual function. This makes it important to further understand which factors differ between women who do experience their sexual problems as distressing, and those women who do not experience them as distressing.

Burri and colleagues (2011) identified that sexual distress is affected by genes, but that the majority (54%) of the variance in sexual distress is explained by non-shared environmental factors. Empirical studies have identified factors beyond sexual function that have been shown to affect the development of sexual distress. Individual factors such as depression and anxiety have been linked to sexual distress: Hayes and colleagues (2008) observed that depressed women were three times more likely to experience sexual distress than nondepressed women. Anxiety sensitivity has also been identified to have a positive association with sexual distress (Burri et al., 2011). Furthermore, Dennerstein and colleagues (2008) compared women who were not sexually distressed and women who were and observed that women who experienced sexual distress were more likely to report lower overall well-being, higher negative mood as well as lower positive mood. Disordered eating behavior have also been linked to higher levels of sexual distress (Dunkley, 2015). Additionally, relationship factors such as emotional well-being in the relationship and intimacy during sexual activity have been shown to predict low sexual distress better than high sexual functioning (Bancroft et al., 2003; Dundon & Rellini, 2010). Additional studies have observed a mediating effect of some of the above-mentioned variables. Gunst and colleagues (2018) observed that the relationship between psychological distress and sexual functioning was mediated by sexual distress. Other mediating factors include childhood

sexual abuse, decreased physical pleasure and disrupted sexual activity (Stephenson & Meston, 2015).

One important notion to point out is also the relationship between sexual distress and sexual satisfaction. Many researchers have theorized them to be codependent constructs, where for example the experience of high sexual satisfaction would imply a lack of sexual distress and vice versa. However, other researchers have claimed that the relationship might not be fully linear. They have claimed that the relationship between sexual distress and sexual satisfaction could be, to a degree, independent (Snyder & Berg, 1983; Lief, 2001). A study conducted by Stephenson and Meston (2010) observed that there were differences in the experiences of sexual satisfaction and sexual distress in clinical and non-clinical samples of women (women with diminished FSF versus women with a diagnosed FSD). They observed that sexual distress was more closely related to sexual functioning domains in the clinical sample than sexual satisfaction. In the non-clinical sample, sexual satisfaction was more closely related to different relationship factors than it was to sexual distress. The present study could help give insight into this relationship as our high distress group can be thought of as a help-seeking group and the low distress group can be thought of as a “non-clinical” group that might not feel the need to seek treatment.

A central question in the FSD research field is why sexual functioning problems are distressing to some, but not all, women. The research indicates that there are many interpersonal and intrapersonal factors, beyond sexual function, that has been identified to be associated with the relationship between sexual distress and sexual functioning. Additionally, the relationship between sexual distress and sexual satisfaction is unclear. The aim of this study is to create three complex network models. Many of these interpersonal and intrapersonal variables will be included in the networks, with measures of sexual function as

well, in the hope of understanding and untangling the complex interplay between these factors.

Aims and hypotheses

The aim of the present study is to investigate between-person network structures of FSF and other identified correlates associated with FSF in women presenting low, moderate and high levels of sexual distress. My aim is to test five theoretically motivated hypotheses relating to the structure and nature of the symptom networks. Furthermore, I had the additional aim to explore the estimated symptom networks in the hope of gaining insight that could assist in clinical practice and in further hypothesis-testing studies.

The following hypotheses were tested:

1) The structure of the symptom networks of women who experience higher level of sexual distress differs from women who experience lower levels of sexual distress.
2) Women with higher levels of sexual distress show stronger positive connections with negatively valenced variables (e.g., depression, anxiety and sex-related pain)
3) Women with lower levels of sexual distress show stronger positive connections among positively valenced variables (e.g., sexual satisfaction and orgasm function).
4) The non-sexuality related negatively valenced variables (e.g., depression, anxiety, body dissatisfaction) show more negative associations to the FSF nodes in the high distress group.
5) The network with high levels of sexual distress displays less fragmentation and forms a fewer number of larger node communities in comparison with the networks with lower levels of sexual distress.

Lastly, as a part of the explorative aims of the study networks are investigated visually with the goal of identifying the most central nodes and important edges. My hope is that the

explorative results could help to provide a better understanding of the complex interaction among the included variables as well as assist in further hypothesis-testing research and give new insights to clinical interventions. The networks included in this study encompassed variables measuring sexual function, childhood maltreatment, psychological distress (depression, anxiety, disordered eating, body dissatisfaction and sexual body image), alcohol use, sociosexual orientation and body-mass index (BMI).

Method

Participants

The sample of the present study was based on questionnaire responses from 3,144 Finnish women between 18 and 49 years (*mean age* = 26.4 years, *SD = 5.1*) who had taken part in a large-scale Finnish population-based study. The data we used was collected during the first collection phase in 2006 (the Genetics of Sexuality and Aggression study; see Johansson et al., 2013). The original sample consisted of 6,215 female twins and sisters of twins. As sexual function can vary as a function of relationship status, and as sexual functioning complaints usually arise in the context of long-term relationships, we chose to only include women who reported being in a relationship for statistical analyses and ended up with a sample of 4,694 participants. Furthermore, to avoid statistical bias arising from genetic relatedness, we randomly selected one person per family from the remaining sample, which resulted in a sample of 3,281 participants. Quantitative variables that had missing values were imputed as network estimations require full information from participants (this step is described further in the Statistical Analyses section). Three equally sized subgroups were created (described in more detailed further) with each group consisting of 1,048 participants, bringing the final total sample to 3,144 participants.

An ethical research permit was obtained for the original data collection from the Ethics Committee of Åbo Akademi University, in accordance with the Helsinki Declaration. The purpose of the study was clearly described, and the voluntary and anonymous nature of the participation emphasized. Written informed consent was obtained from all participants.

Measures

Female sexual function. The Female Sexual Function Index (FSFI; Rosen et al., 2000) was used to assess sexual function. The FSFI questionnaire consists of 19 Likert-type items, which assess sexual functioning in six different domains during the timespan of four weeks. The domains included in the FSFI are sexual desire, sexual arousal, lubrication, orgasm function, sexual satisfaction and sex-related pain. Scores for items range from 1 to 5 or 0 to 5 with lower scores representing worse sexual functioning and 0 indicating the option of "*no sexual activity" / "did not attempt intercourse*". Items 14 ("*how satisfied have you been with the amount of emotional closeness during sexual activity between you and your partner?*") and 15 ("*how satisfied have you been with your sexual relationship with your partner?*") were modified by adding the response option "*no sex*" / "*partnered activity*". In order to match with other response options in the questionnaire, this option was given the value of 0. Higher scores in the measure indicated higher sexual function. Composite variables for each domain were calculated according to the guidelines described in Rosen et al. (2000).

The FSFI is widely used in clinical and research settings and has repeatedly shown good validity and reliability (Rosen et al., 2000; Witting et al., 2008a). In the present study, the internal consistency of all six FSFI domains ranged from acceptable to excellent (Cronbach's α's varied from .77 to .95).

Sexual distress. A brief version of the Female Sexual Distress Scale (FSDS; Derogatis et al., 2002) was used to assess the experience of sexual distress during the past four weeks. The

brief version consisted of seven Likert-type items, picked from the original 12-item questionnaire (items 1, 3, 5, 8, 9, 10 and 11). Items included in the questionnaire were such as *"how often did you feel distressed about your sex life"* (item 1) and *"how often did you feel dissatisfied with your sex life"* (item 11). The items were summed together to form a composite variable that ranged from 0 to 28, with higher scores indicating higher sexual distress. In previous studies the FSDS has demonstrated sound psychometric capabilities with a high degree of internal consistency, test-retest reliability and high discriminative validity (Derogatis et al., 2002). In the present study the measure showed good internal consistency ($\alpha = .90$).

Depression and anxiety. Depression and anxiety dimensions of the DSFI subscale Brief Symptom Inventory (BSI; Derogatis & Melisarotos, 1979) were used to measure the level of participants' depression and anxiety. Both dimensions consist of six Likert-type items that range from 0 "*Not at all*" to 5 "*Extremely*". Two composite variables (depression and anxiety) were formed by summing together the corresponding items from each dimension. The composite variables ranged from 6-30, with higher scores indicating higher levels of psychological distress. In the present study both dimensions showed good internal consistency (Cronbach's α for depression was .84 and .85 for anxiety)

Childhood maltreatment. The Childhood Trauma Questionnaire (CTQ; Bernstein & Fink., 1997) was used to assess self-reported experiences of childhood abuse and neglect. The CTQ consists of 28 items divided into five different domains with five items each; physical abuse, sexual abuse, emotional abuse, physical neglect, emotional neglect. Composite variables were created by summing together each item in the corresponding subscale resulting in five different composite variables ranging from 5 to 25. Higher scores indicated a more severe

experience of abuse or neglect. The three-item minimization/denial subscale of the CTQ that measures false negatives was not included in the present analyses because its relevance in clinical context is ambiguous (Gerdner & Allgulander, 2009; MacDonald, Thomas, MacDonald, & Sciolla, 2015). The validity of the CTQ questionnaire has been shown to be good in clinical samples (Gerdner & Allgulander, 2009). The 25 CTQ items showed excellent internal consistency in the present study ($\alpha = .87$)

Body dissatisfaction. Body dissatisfaction was assessed by using the body image scale from Derogatis Sexual Function Inventory (DSFI; Derogatis & Melisarotos, 1979). The body image scale consisted of 11 gender-neutral Likert-type items that were summed together to form a composite variable on general body image, ranging from 11 to 55, with higher scores meaning higher levels of body dissatisfaction. Two gender-specific items from the DSFI body image scale were used to assess sexual body image. Items "*I have attractive breasts*" and "*I am pleased with the way my genitals look*" were summed together to form a composite variable ranging from 0 to 12 with higher scores indicating higher sexual body dissatisfaction. In past studies DSFI has demonstrated good validity and reliability in different settings measuring sexual function (Daker-White, 2002). The body dissatisfaction composite variable used in the present study demonstrated questionable internal consistency ($\alpha = .69$). The sexual body image composite variable created from only two items expectedly demonstrated poor internal consistency ($\alpha = .41$).

Disordered eating. Disordered eating was assessed by using five Likert-type items from the Eating Attitudes Test 26 (EAT-26; Garner, Bohr, & Garfinkel, 1982). The five items were chosen because they assess both anorexic and bulimic attitudes and behavior. The composite variable created from the items ranged from 5-25 with higher values indicating more

problematic attitudes towards eating. The EAT-26 has showed good to excellent internal consistency in prior studies (Doninger, Enders, & Burnett, 2005; Garner et al., 1982; Joiner & Kashubeck, 1996; Koslowsky et al., 1992). In the present study the composite variable demonstrated acceptable internal consistency (Cronbach's $\alpha = .77$).

Alcohol use. The Alcohol Use Disorders Identification Test for Consumption (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001) was used to assess hazardous alcohol use. AUDIT-C consists of the three items Likert-type items ranging from 0 to 4. The items were summed together to form a composite variable ranging from 0 to 12, where higher scores indicated a more frequent and hazardous alcohol use. Prior studies have shown that the AUDIT-C is a psychometrically valid and reliable screening tool in various settings (Campbell & Maisto, 2017; Osaki et al., 2014; Barry, Chaney, Stellefson, & Dodd, 2013; Bradley et al., 2007). Audit-C demonstrated poor internal consistency (Cronbach's $\alpha = .56$)

Sociosexual orientation. Sociosexual orientation was assessed by The Sociosexual Orientation Inventory (SOI; Simpson & Gangestad, 1991). Sociosexual orientation is an indication of a person's attitudes and tendencies to engage in casual and uncommitted sexual relations. The sociosexual orientation inventory consists of a total of seven items, four nine-point Likert-type items measuring attitudes and three open ended numerical items that measure behavior with higher scores indicating more unrestricted sociosexual orientation. The composite variable was constructed according to the formula from Simpson & Gangestad (1991). Winsorization was implemented on items 1-3 because they lacked a theoretical upper limit (the procedure is detailed further in the section Statistical Analyses). In previous studies the SOI has demonstrated good internal consistency. In the present study SOI demonstrated poor internal consistency (Cronbach's $\alpha = .47$)

Body mass index. Body mass index (BMI) was also included in the analyses and was calculated from the participants height and weight. BMI is calculated by dividing the participants' weight (kg) with the square of the participants' height (m) ((BMI = [kg] / [m]2). BMI is used to assess if the person is over- or underweight. A score over 25 is considered overweight, a score between 18.5-25 is considered to represent normal weight and a score under 18.5 is considered to be underweight. ("Body mass index - BMI", 2019).

Statistical Analyses

Data preparation.

SPSS 25.0 for Mac software (SPSS Inc., 2008) was used for data preparation, for the creation of the composite variables and for the creation of the sexual distress groups. Network analyses were done with the R software packages (R Core Team, 2018; see below for a more detailed description).

The total proportion of missing values in the included variables was 6.5%. Missing values were imputed by using the Regression Method procedure of the Missing Value Analysis in SPSS. All quantitative study variables were used as both predicted and predictor variables.

When comparing networks between groups it is crucial that the sample size for each subgroup is of the same size. Unequal subgroups could affect the power of the estimated relationships and thusly affect the estimated network structures, potentially leading to biased estimates (Epskamp et al., 2017). To avoid this, we created three equally sized subgroups by randomly allocating 1,048 participants to each of the three subgroups (the size of the smallest group was 1,048) and ending up with a final total sample of 3,144 participants. The distress groups were constructed by using the Female Sexual Distress Scale (FSDS; Derogatis et al., 2002) as a grouping variable. Three groups were formed based on the 33rd and 66th

percentiles of the FSDS scores; a) Low group with low sexual distress (women with scores ranging from 0-3.0), b) Moderate group with moderate levels of sexual distress (women with scores ranging from 3.1-9.0) and c) High group with high levels of sexual distress (women with scores ranging from 9.1-28).

Network analyses.

The data was analyzed using network packages in R version 3.5.2 (R Core Team, 2018) utilizing R Studio version 1.2.335. The network structures were estimated and plotted separately for each distress group. Then, several analyses in R Studio were run on each network, in order to determine the accuracy and stability of the estimated networks and their parameters.

The networks were estimated with the bootnet-package (Epskamp, Borsboom, & Fried, 2018). The bootnet package estimates a partial correlation network which is a type of Gaussian graphical model (GGM; Epskamp & Fried, 2018). In a GGM, different observable variables are represented by nodes and connections between nodes are represented by undirected edges. Edges between variables indicate conditional dependence between the variables and the absence of an edge indicates that the two variables are independent after conditioning on (i.e., controlling for) all other variables in the network. In GGMs, each edge in the network can directly be interpreted as partial correlation coefficients (Epskamp, Waldorp, Mõttus, & Borsboom, 2018). Due to sampling variation, the partial correlations obtained are never exactly zero and therefore the estimated network can contain weak spurious edges that do not exist in the true network (Epskamp & Fried, 2018). In order to obtain the best fit for the model and minimize spurious edges, regularization techniques were utilized. Regularization sets a limit on the sum of absolute partial coefficients and as a result, all estimations shrink, and some become exactly zero. We implemented the most commonly used regularization techniques for partial correlation networks, namely graphical lasso

(glasso) in combination with extended Bayesian Information Criterion (EBIC). The glasso algorithm shrinks small partial correlation coefficients to zero when estimating a network model, which results in a sparser network with fewer connections. The degree of regularization applied by the glasso algorithm is controlled by a tuning parameter γ (gamma). The tuning parameter γ was set to 0.5 as suggested in the literature (Epskamp & Fried, 2018). As recommended, we also implemented the thresholded version of EBICglasso to ensure a low rate of false positives (i.e., a low number of edges detected to be nonzero that are zero in the true model).

The networks were visualized using the *qgraph*-package (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). The layout of each individual network was determined by the Fruchterman-Reingold algorithm, which organizes the network in a way where nodes that are strongly connected attract each other whereas nodes that are disconnected repulse each other (Epskamp et al., 2012). When plotting the networks, an average layout across the three networks was used in order to make the networks visually comparable with each other.

Network stability

After estimating and visualizing the networks, the *bootnet*-package (Epskamp et al., 2017) was used to formally inspect the networks' accuracy and stability. As a first measure, we ran tests to assess the accuracy of edge-weights. Edge-weights are magnitudes of the regularized partial correlations that are estimated between nodes. The *bootnet* package was first used to compute bootstrapped 95% confidence intervals (CIs) for all the estimated edges, so that the edge-magnitudes for each network were re-estimated several times. The resulting CIs are presented as edge stability plots in the appendix. The *bootnet* package was also used to visualize edge significance plots, which uses the same non-parametric bootstrap results as the

edge stability plots. However, the edge significance plots display the bootstrapped difference tests between edge-weights that were non-zero in the estimated network. The bootstrap was performed with 2,500 samples, as recommended in the literature (Epskamp et al., 2017). If the resulting confidence intervals are wide, it means that the estimated variables varied a lot across resamples. In turn, if the confidence intervals are narrow, it means that the estimated variables were estimated with less variability. The bootstrapped CIs can also be used to compare two different edge-weights from the same network with each other and to distinguish if the two edges differ from each other significantly in strength. By visually inspecting the bootstrapped CIs it might seem that some edges are stronger than others, however, if two edges have overlapping CIs this indicates that they are not meaningfully different from each other. When two pairs of edges share bootstrapped values with each other it means that they have same estimated values in their confidence intervals, therefore, it cannot be determined that they differ from each other. Conversely, if two edges do not have any overlap with their bootstrapped CIs we can more confidently determine that they differ from each other in edge strength as they do not share any bootstrapped values with each other. The edge significance plot on the other hand, shows only significant differences in edge-magnitudes, it cannot be used to determine if an edge is significantly different from zero (Epskamp et al., 2018). This is due to the regularization process that was done in the network estimation phase where small edges were shrinked in order to minimize the number of spurious edges. Therefore, if the connection is present in the network after regularization, there is confidence to believe that it already is different from zero.

Node centrality

Node centrality is a way to determine the importance and influence of individual nodes. A node with high centrality has a lot of predictive power in the network. We used the *qgraph*

package (Epskamp et al., 2018) to compute centrality statistics. The most common centrality estimates used in graph theory are strength, betweenness and closeness. However, as Bringmann and colleagues (2018) have pointed out, the applicability of betweenness and closeness centrality transfer questionably to psychological network analysis. Therefore, we decided only to estimate and analyze the strength centrality estimate. Strength centrality is an estimate that quantifies the absolute sum of all partial correlations (positive or negative) connected to a node. In other words, it quantifies the degree of partial correlations (edge-magnitudes) the node has with other nodes in the network. Before analyzing the strength centrality and the importance of individual nodes, a stability test on the strength centrality estimates was performed. The stability test is performed as a non-parametric case-dropping bootstrapping test. This involves re-estimating the centrality parameter several times by creating subsets of the data where an ascending number of cases (individuals in the dataset) are dropped from the data. After this, the correlations between the original centrality parameter (with the full sample) and the subsets are compared. The centrality parameter is deemed instable if there is a large discrepancy between the correlations after dropping a small percentage of cases. Strength stability can furthermore be quantified with the centrality stability coefficient (CS-coefficient; Epskamp et al., 2017). The CS-coefficient is a correlational value that quantifies the maximum proportion of cases that can be dropped in order to retain a high enough correlation with the original centrality. The CS-coefficient should be higher than 0.7, or at least above 0.5 to be considered reliable (Epskamp et al., 2018).

Network comparison test

The *NetworkComparisonTest* (NCT; van Borkulo et al., 2017) package was used to statistically compare the networks with each other. The NCT is a permutation-based test that

checks three different invariance hypotheses. The first hypothesis examines the overall structure of the network, it tests if the networks are structurally identical with each other when considering the edges present in the networks and their positive or negative valence. The second hypothesis examines global strength between the networks, that is, if the overall connectivity (i.e., sum of all absolute edge values) between the networks are identical. The third test focuses on the strength of individual edges and examines if they are identical across different networks. The third test is run only if the first hypothesis is discarded, because if there are no structural-level differences between the networks there is no need to test for differences between individual edges. The NCT was run a total of three times; comparing the low network with the high network, moderate network with the high network and lastly, the low network with the moderate network.

Network communities

Community analysis can be used to determine the level of fragmentiation in a network. The level of fragmentation is based on how densely nodes are connected to each other and which edges are missing (i.e., what parts of the network are less connected to each other) A highly fragmented network consists of many communities (i.e., many small communities consisting of few nodes). A less fragmented network consists of only a few communities (i.e., few but large communities consisting of many nodes). In network theory it is hypothesized that when nodes form larger communities, they have a stronger effect on each other, and they act in a more synchronized manner. This makes the whole node community more sensitive to symptom activation. Therefore, the nodes can activate or deactivate each other more easily due to being more closely related and having stronger influence on each other. The opposite is true when nodes form many small node communities. These smaller communities are not

as sensitive to symptom activation and the spreading of the symptom activation is more limited due to the nodes not being as closely related to each other.

The level of network fragmentation was formally assessed with the *Walktrap* algorithm from the *igraph*-package (Csárdi & Nepusz, 2014). The algorithm chooses random paths ("walks") across the network and uses these routes to detect and identify node activation patterns that form distinct node communities or clusters. In our analyses we set the number of steps to 200, as it resulted in a stable number of clusters.

Results

Descriptive statistics for all variables are presented in Table 1. Formal review of the results relating to the Network Comparison Test (NCT) and community analysis are presented first. Then follow the results of the accuracy and difference tests. Lastly, visual comparisons between the three different networks are presented.

Table 1
Descriptive Statistics for the women with low, moderate and high levels of sexual distress

	Low	Moderate	High
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
BMI	22.94 (4.14)	23.03 (4.06)	23.13 (4.23)
Depression	3.17 (3.28)	4.44 (3.71)	6.63 (4.81)
Anxiety	2.55 (3.09)	3.30 (3.48)	5.07 (4.61)
Body image	23.84 (6.16)	25.74 (5.78)	28.17 (6.22)
Sexual body image	4.77 (1.74)	5.23 (1.82)	5.78 (1.90)
Emotional Abuse	7.37 (3.46)	7.75 (3.48)	8.77 (4.12)
Physical abuse	6.40 (2.62)	6.46 (2.53)	6.85 (3.09)
Sexual abuse	5.43 (1.99)	5.63 (2.22)	5.87 (2.75)
Emotional neglect	8 (3.58)	8.67 (3.71)	9.70 (4.22)
Physical neglect	9.40 (1.68)	9.48 (1.73)	9.67 (1.99)
Desire	3.56 (0.82)	3.35 (0.82)	2.94 (0.92)
Arousal	5.31 (0.94)	4.98 (1.07)	4.25 (1.45)
Lubrication	5.71 (0.87)	5.48 (1.03)	4.97 (1.46)
Orgasm	4.87 (1.38)	4.42 (1.53)	3.70 (1.79)
Satisfaction	5.56 (0.83)	5.01 (1.07)	4.06 (1.43)
Pain	5.54 (1.14)	5.22 (1.38)	4.68 (1.78)
Alcohol	3.97 (2.03)	4.14 (2.02)	4.21 (2.08)
Disordered eating	11.23 (4.92)	12.16 (4.74)	13.59 (4.91)
Sociosexual orientation	59.21 (32.99)	61.45 (37.86)	62.26 (36.26)

Note. N in all groups = 1048; *M* = mean; *SD* = standard deviation; BMI = body mass index. Participants were divided into sexual distress groups according to the 33rd and 66th percentiles of the FSDS measure. Low group = scores ranging from 0-3.0, Moderate group = scores ranging from 3.1-9.0, and High group = scores ranging from 9.1-28.0.

Network comparison

All three networks had approximately the same number of edges (see Figure 1). The number of retrieved edges (non-zero partial correlations) varied between 21 and 24. The moderate distress network had the least number of edges (21), the low distress network was second (23) and the high distress network had the highest number of edges (24). Overall network connectivity (the sum of all absolute edge-magnitudes) was strongest in the high distress network (6.93) followed by the moderate distress network (6.55) and the low distress network (6.38). Visually compared, the three networks were also quite similar in structure overall, with many of the same edges present in all of the three networks. Estimated edges were mostly of the same magnitude and direction. No edges changed direction between the three networks.

Results relating to the first hypothesis of the NCT yielded no significant findings regarding structural differences between the networks. This means that the three networks were statistically similar considering the nature and magnitude of individual edges (high vs moderate $p = 0.07$, low vs high $p = 0.19$, low vs moderate $p = 0.93$) and no statistically significant differences between the networks were observed. The networks that were close to being significantly different in structure was the moderate and high networks. The value of maximum differences in edge-weights between the networks was 0.136 ($p = 0.07$). The second hypothesis of the NCT, which was concerned with differences in overall network connectivity (the sum of all absolute partial correlations) between the networks, was also not significant. The third hypothesis of the NCT was discarded as no significant differences between the networks were found. These results entail that the visual differences between the networks presented later on are not significant and should be interpreted accordingly.

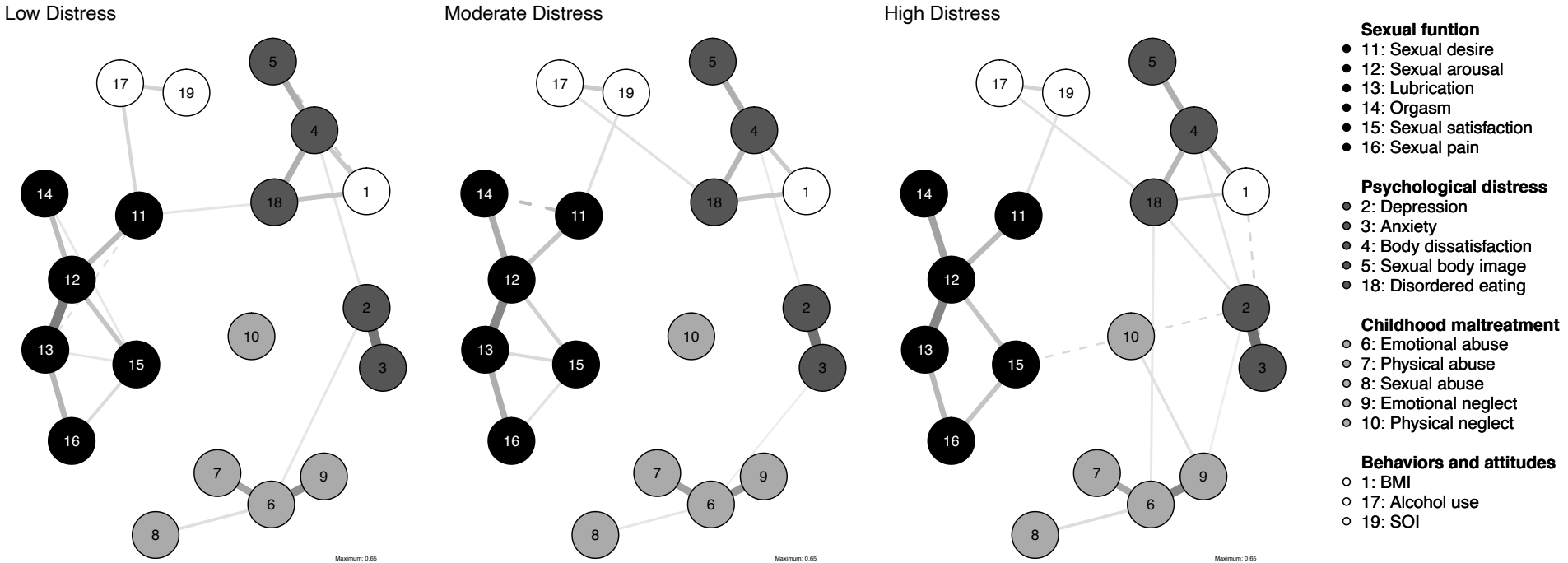


Figure 2. The three gaussian graphical model (GGM) networks for the different distress groups. Low = women with low levels of sexual distress, Moderate = women with moderate levels of sexual distress, High = women with high levels of sexual distress. Solid gray edges represent positive partial correlations. Dashed gray edges represent negative partial correlations. Networks are visualized according to the Fruchtermann-Reingold algoritm and an averaged layout of the three networks are presented here to make the networks comparable.

Network communities

Community analysis revealed differences in how the nodes formed communities with each other depending on the level of distress. The number of communities and the content of the node communities varied between each distress group. The low and moderate groups had a total of seven communities each and the high group had four communities (see Figure 4). This means that the network for women with high levels sexual distress was less fragmented (i.e., that symptoms are more tightly connected to each other in the group with high sexual distress) than the two other networks. Even though the low and moderate networks had the same number of communities, the communities differed from each other in terms of size and constitution.

The low distress group consisted of two larger communities and five smaller ones. The largest community included five nodes from the FSF domain: orgasm, arousal, lubrication, satisfaction and pain, but not desire. The second largest community had four nodes (sexual abuse, physical abuse, emotional abuse and emotional neglect). Hazardous alcohol use, sociosexual orientation and sexual desire composed a three-node community. There were three two-node communities; one with body image and sexual body image, another with disordered eating and BMI and a third with depression and anxiety. The physical neglect node was not connected to any other node.

The moderate distress group had three larger communities and four smaller ones. The largest community consisted of six nodes; four maltreatment nodes and two psychological distress nodes (depression and anxiety). The second largest communities consisted of four nodes each. One of these communities consisted of the FSF domains arousal, lubrication, pain and satisfaction. The other one consisted of disordered eating, BMI, body image and sexual body image nodes. Hazardous alcohol use and sociosexual orientation composed a two-node community.

The high distress group consisted of two larger communities and two smaller ones. The largest community in the network consisted of a total of nine nodes, including all five childhood maltreatment nodes, disordered eating, BMI, body image and sexual body image. The second largest community comprised of all the six FSF domains. Depression and anxiety comprised a two-node community likewise to hazardous alcohol use and sociosexual orientation.

To summarize, the number of communities was stable across the low and moderate distress networks as both had seven communities. The number of communities decreased in the high distress network where four communities was observed. The decrease in number of communities indicates that the nodes in the high distress network may have a stronger impact on each other, which can cause a faster and more efficient activation of neighboring nodes. In other words, symptom activation can spread faster in networks with fewer and larger communities and can therefore lead to a situation where one or two symptoms affect and activate neighboring symptoms in a more effective manner and cause the whole network to become activated.

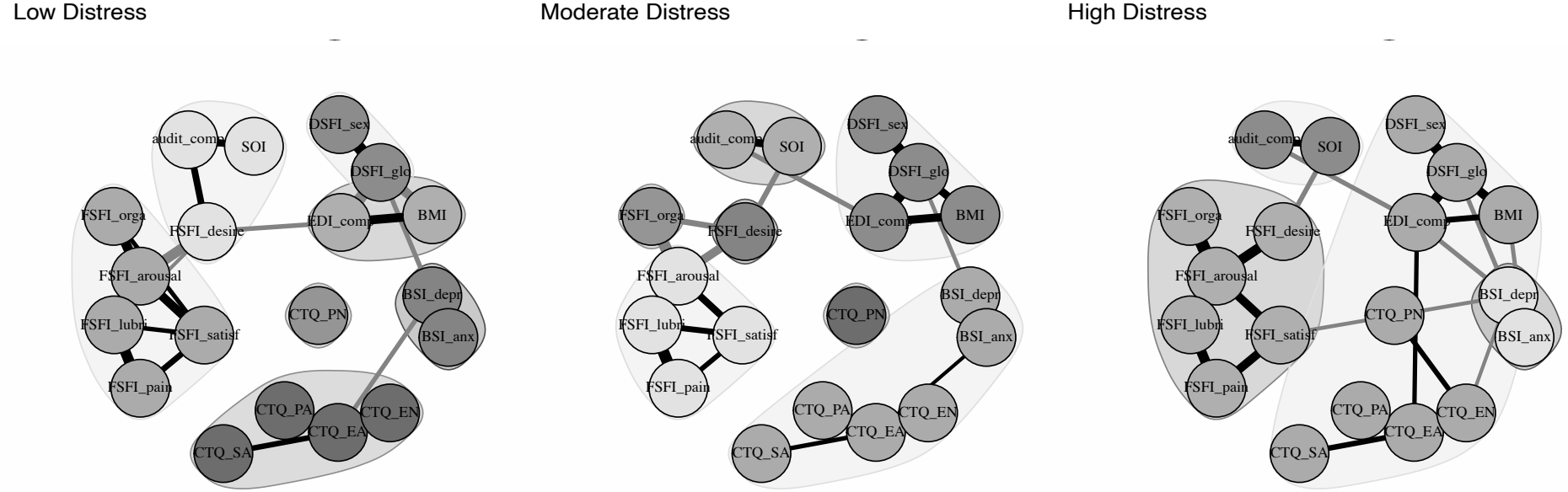


Figure 3. Node communities for the three distress Gaussian graphical model (GGM) networks presented in Figure 1. Communities are based on the walktrap algorithm and are represented as nodes inside distinct clouds. Low and the moderate distress groups show seven communities each and the high distress group shows four communities. FSFI_orga = orgasm, FSFI_arousal = arousal, FSFI_lubri = lubrication, FSFI_satisf = sexual satisfaction, FSFI_pain = sexual related pain, FSFI_desire, CTQ_SA = sexual abuse, CTQ_PA = physical abuse, CTQ_EA = emotional abuse, CTQ_EN = emotional neglect, CTQ_PN = physical neglect, BSI_anx = anxiety, BSI_depr = depression, audit_comp = (hazardous) alcohol use, SOI = sociosexual orientation, DSFI_sex = sexual body image, EDI_comp = disordered eating, BMI = body mass index. A colored version of the same figure can be found in the appendix chapter 3.

Edge stability results

The results from the bootstrapped edge stability analysis (presented in appendix chapter 1.2) showed considerable variation in the edge-weight estimates. This implies that the order of the edge-magnitudes is unstable and that the observed differences in edge-magnitude should be interpreted with caution. The order of the edge-magnitudes showed minor variation across the distress groups. Only the edge between anxiety and depression in the high distress group did not have any 95% CIs overlap with other edges and it could be considered reliable. The results were otherwise similar as the plots for the three distress groups resembled each other.

Edge-weight significance plots (see appendix chapter 2.1) revelead similar results for all three networks. For example, edges between depression and anxiety, arousal and lubrication, and emotional abuse and emotional neglect were significantly stronger from the rest of the edges in all three networks.

Differences in Node Strength

Strength stability analyses for all distress groups were stable as the results showed that a high correlation (above 0.7) was maintained despite dropping 70% of the cases (plots for the strength stability analyses are presented in appendix chapter 1.1). The node strength estimates for all three networks are presented in Figure 4. The pattern of the node strength estimates for all three networks were quite similar. Sexual arousal was the most central node in all networks and indicates that of all the nodes included in the networks sexual arousal had the strongest tendency to influence and to be influenced by its neighboring nodes. The second most central node in the networks was emotional abuse. For the low and moderate distress groups lubrication was the third most central node, in the high group it was the body dissatisfaction node. However, one interesting difference in centrality was observed. The centrality of the depression and emotional neglect nodes increased in the high group, which

implies that the influence that these nodes had on other nodes was higher in women who experienced higher levels of sexual distress.

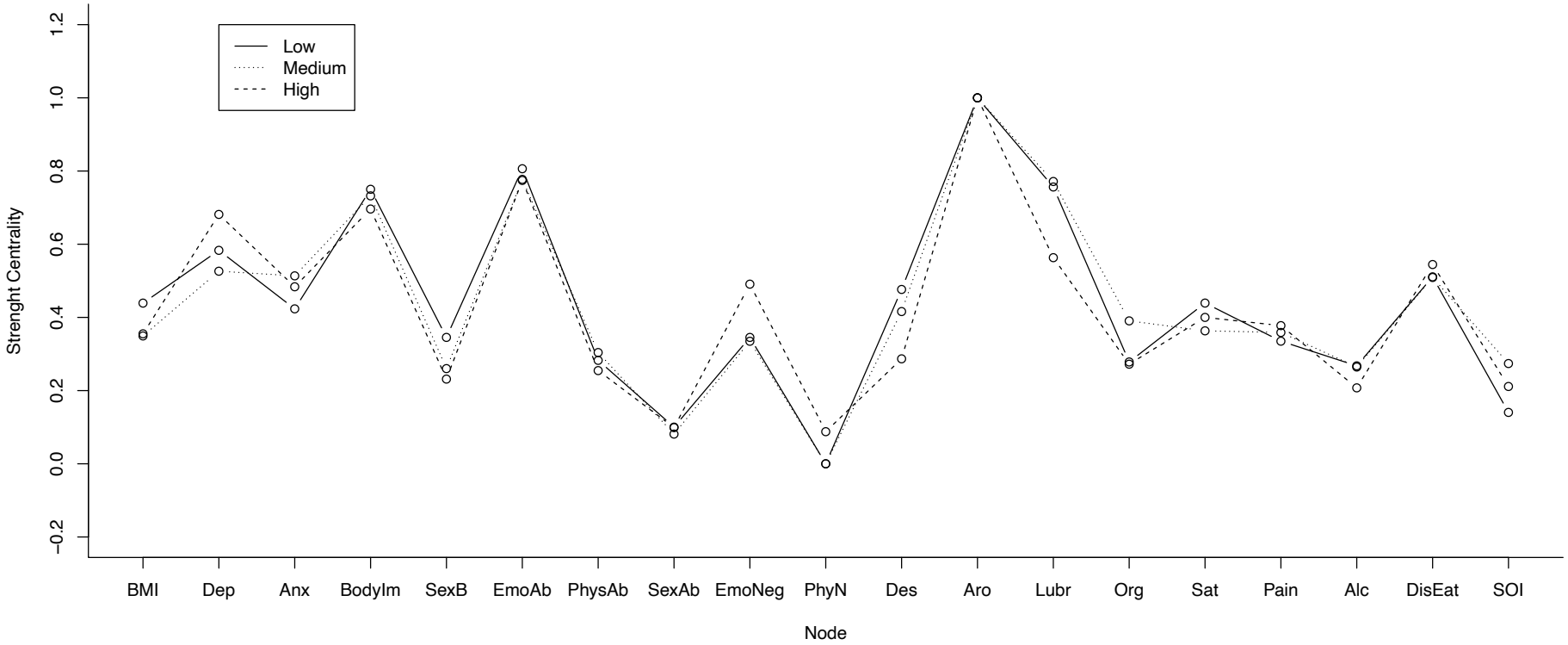


Figure 4. Node strength centrality for the three distress groups. Low = women with low levels of sexual distress, Moderate = women with moderate levels of sexual distress, High = women with high levels of sexual distress. BMI = body mass index, Dep = depression, Anx = anxiety, BodyIm = body image, SexB = sexual body image, EmoAb = emotional abuse, PhysAb = physical abuse, SexAb = sexual abuse, EmoNeg = emotional neglect, PhysN = physical neglect, Des = sexual desire, Aro = sexual arousal, Lubr = lubrication, Org = Orgasm, Sat = sexual satisfaction, Pain = sex-related pain, Alc = (hazardous) alcohol use, DisEat = disordered eating, SOI = sociosexual orientation.

Visual comparison

Upon visual comparison, nodes measuring FSF were quite similar in all distress groups. Sexual arousal was the most central node in all the three distress groups, and it was positively connected to orgasm, desire, sexual satisfaction and lubrication in all three networks. However, a few differences were observed. The number of edges among the FSF nodes decreased between the low distress network and the moderate distress network. The edges decreased also between the moderate distress network and the high distress network. The low distress group had a positive edge between orgasm function and satisfaction, which was not present in the networks of the other two groups. This suggests that women with low levels of sexual distress who report high levels of orgasm function are also more likely to report high levels of sexual satisfaction. Additionally, the low distress group had a negative edge between lubrication and desire, which was not present in the other networks. This means that women who report fewer lubrication problems during intercourse are more likely also to report low levels of sexual desire in the low distress group. In the moderate distress network, there was only one negative edge, which was between the orgasm and desire nodes. This finding suggests that women who reported low levels of orgasm function also tended to report high levels of desire and those women who reported high levels desire also tended to report low levels of orgasm function. The low and moderate distress groups also had a positive edge between lubrication and satisfaction that was absent from the high distress group. Meaning that fewer lubrication problems was positively associated with high levels of satisfaction among women with low and moderate levels of sexual distress.

The structure of the childhood maltreatment nodes had some similarities across the distress groups. Four of the maltreatment nodes (emotional abuse, sexual abuse, physical abuse and emotional neglect) shared edges with each other in all distress networks. However, the physical neglect node was separated from the other maltreatment nodes. In the low and

moderate networks, physical neglect was not connected to any other nodes. In the high network physical neglect had a positive association with emotional neglect. No direct edges connected the sexual function variables to the maltreatment variables in any group. Emotional abuse was the most central of the maltreatment nodes in all distress groups. All edges were of positive value and no negative edges were observed. However, the number of edges from the maltreatment nodes to other nodes varied depending on the level of distress. Both the low and moderate distress groups had one edge between the maltreatment nodes and the other nodes in the network. In the low group this edge was between emotional abuse and depression. In the moderate group the lone edge was between emotional abuse and anxiety. This indicates that for women with low levels of sexual distress a high level of emotional abuse was associated with more depressive symptomatology. Additionally, for women who experienced moderate levels of sexual distress a high level of emotional abuse was associated with more symptoms of anxiety. The number of edges between the maltreatment nodes and other nodes in the network increased in the high distress group, as they had a total of three edges to other nodes. One edge was between emotional abuse and disordered eating and another was between emotional neglect and depression. Additonally, in the high distress group, emotional neglect had a positive edge with physical neglect that was not present in the other networks.

Connections between sexual function and psychological distress

The FSF nodes were connected to the psychological distress variables only in the low and high distress groups. In the low distress group, sexual desire was positively associated with disordered eating and in the high group sexual satisfaction was negatively associated with depression. In other words, high levels of sexual desire corresponded with high levels disordered eating behavior in women with low sexual distress. For women experiencing high

levels of sexual distress, a high level of sexual satisfaction was associated with fewer symptoms of depression. The moderate distress group had only one indirect edge between the psychological distress and sexual function nodes, the desire domain was connected to disordered eating via sociosexual orientation and alcohol use.

The nature and number of edges between the psychological distress nodes and other nodes varied depending on the level of sexual distress. In all three groups, the depression and anxiety nodes had a positive edge with each other. However, in the high group the depression node had four unique edges to other nodes, two positive edges (to emotional neglect and to disordered eating) and two negative edges (to sexual satisfaction and to BMI), that were not present in the other two groups.

Connections between SOI, alcohol use and sexual function

Nodes measuring SOI and alcohol consumption differed somewhat between the distress groups. In all groups, sociosexual orientation and alcohol use were connected with each other. Differences emerged when comparing how these two nodes were connected to other nodes in the networks. The low distress group had only one edge connecting the alcohol use node and the sociosexual orientation node to the sexual function nodes, and that edge was between alcohol use and the FSF domain desire. The moderate and high groups had two similar edges connecting alcohol use and sociosexual orientation to the sexual function nodes; one edge between alcohol use and disordered eating and another edge between sociosexual orientation and desire.

Discussion

The aim of the present study was to estimate and analyze how varying levels of sexual distress affected symptom networks of female sexual function, psychological distress, alcohol use, sociosexual orientation and childhood maltreatment. We estimated three between-subject networks for women reporting high, moderate and low sexual distress respectively, and then compared the structure and characteristics of these networks. Our main objective was to test five hypotheses. The first hypothesis was concerned with overall network connectivity (overall magnitude of the estimated partial correlations) and structure among the nodes and if there would be any differences in them across the distress groups. In the second hypothesis, we hypothesized that women with higher levels of sexual distress would show stronger connections with the "psychopathological" variables (such as, depression, anxiety and sex-related pain). In the third hypothesis we predicted that women with lower levels of sexual distress would show more positive connections with variables such as sexual satisfaction and orgasm function. The fourth hypothesis was concerned with non-sexually related negative variables (e.g. depression, anxiety, body dissatisfaction and sex-related pain) and we predicted that these variables among women with higher levels of sexual distress would show more negative associations with sexual function variables. None of these assumptions yielded any significant results. Results from the Network Comparison Test revealed that there were no statistically significant differences between the three networks when compared to each other.

The fifth hypothesis concerning network fragmentation (i.e., to what degree nodes would form node communities inside the larger network) was, however, confirmed. The high group displayed less fragmentation and formed fewer node communities in comparison to the low and moderate groups.

Network differences

The Network Comparison Test revealed no significant differences regarding the network structures or the overall network connectivity. This means that the low, moderate and high distress networks did not differ from each other in overall structure formation, in the magnitude of the individual edges or in the sum of all absolute edge-magnitudes even though the high network had the highest number of edges (24). As mentioned, these results fail to support our four first hypotheses. These results mean that despite the visual differences observed between number of edges, nature and direction of edges across networks, the networks were statistically similar to each other. However, a word of caution in interpreting the NCT results is warranted, as it is a recently developed test and its functionality and applicability have been questioned and developments to the NCT have been called for (van Borkulo, 2017; Fried, 2017). This means that the NCT is not without issues and researchers are partly unsure of how stably it performs, however it is also the only existing statistical test for testing differences between two separate networks.

The fifth hypothesis regarding network fragmentation was supported by our results. The low and moderate distress groups showed more fragmentation than the high distress group. The low and moderate groups had seven node communities when the high distress group only had four communities. These results align with the network theory of mental disorders, which proposes that networks that are more densely connected and form bigger node communities inside the main psychopathology network are more vulnerable to ending up in an activated pathological state due to the symptoms co-activating each other more easily within their respective communities. The larger communities that formed in the high distress network mean that the nodes have a stronger predictive effect on each other which could cause that the whole community of nodes is more vulnerable to the activation or deactivation of other nodes in the community. If these cross-sectional group-level symptom

associations would be applicable to within-person symptom dynamics, this would indicate that women who experience higher levels of sexual distress would be more at risk of entering a pathological state due to the activation of a single node. For example, the activation of depressive symptoms could cause a cascade of activation in other psychological or sexual function variables and thusly lead to a more pathological state.

Node level differences and similarities

Despite that no significant findings were discovered between the different networks, there are a couple of interesting observations that are worth pointing out. There was a negative edge between depression and sexual satisfaction only in the high distress network. The connection was absent in the low and moderate distress networks. It could be that the relationship between sexual satisfaction and depression may be moderated by the experience of sexual distress. As the networks were not significantly different, we can only speculate on this finding and its meaning. The results could be interpreted so that women who experience simultaneously high levels of sexual distress and depressive symptomatology could diminish their capability to experience sexual satisfaction. It is also plausible to hypothesize the opposite, that women who experience high levels of sexual distress and low levels of sexual satisfaction at the same time are more likely to develop symptoms of depression.

Visually compared, it was also apparent that the depression node was more connected to other nodes in the high distress group as it had four unique edges that were not present in the other two networks. The depression node was positively connected to emotional neglect and disordered eating and negatively connected to sexual satisfaction and BMI. These differences in the connectivity of depression in the high group could explain why the depression node had a higher centrality in comparison with the other two networks. It is important to note that these findings were not significant in the light of the network comparison results, but they could nonetheless mean that the depression node had a stronger

influence on its neighboring nodes in women who experienced higher levels of sexual distress. Strength centrality results support this finding as the depression node had a higher centrality in the high distress group. These findings could indicate that higher levels in sexual distress could be connected with an increase in overall interconnectedness of the psychopathology variables. These visual differences in connectivity are in line with earlier research, as the experience of sexual distress has been identified to be linked with depression, anxiety, childhood maltreatment and disordered eating (Hayes et al., 2008; Burri et al., 2011; Dunkley; 2009; Stephenson & Meston, 2012). Overarchingly, these findings could mean that for the group of women experiencing high sexual distress and psychological distress, these variables seem to be associated to the level of other measured variables to a larger degree than in the low and moderate distress groups.

The sexual function nodes had more edges between each other in the low and moderate distress networks than in the high network. For example, edges from the sexual satisfaction node decreased from four to three (no edge between satisfaction and orgasm) between low and moderate distress groups and three to two between moderate and high distress groups (no edge between satisfaction and lubrication). This seems to indicate that the sexual function domains have a stronger tendency to affect each other among women who experience lower levels of sexual distress.

Our study also revealed an interesting null finding. There were no direct edges in any of the distress groups connecting the maltreatment variables to the sexual function variables. Therefore, our study does not support the claim of childhood maltreatment having a direct influence on sexual function when taking in account the effects of psychological distress, alcohol use and sociosexual orientation. As the absence of edges was present in all three distress networks, it indicates that the results were not moderated by sexual distress. These visual findings do not support results of previous research, which have suggested that

the connection between sexual function and sexual distress is moderated by childhood sexual abuse (e.g., Stephenson, Hughan, & Meston, 2012; Najman, Dunne, Purdie, Boyle, & Coxeter, 2005). Additionally, it is likely that the perceived association between childhood maltreatment and sexual dysfunction that has been observed in other studies (Pulverman, Kilimnik, & Meston, 2017) is likely not direct and moderated by factors not captured in my model. There might also be differences between population- and clinical-based samples. In practice this would mean that the prevalence rate of childhood maltreatment in population-based samples would be so low that the variable would have a very skewed distribution. The low prevalence and skewed distribution would therefore explain why no effects would be found in a network model. Overall, the maltreatment nodes were quite similar in all three groups, however, the number of edges from the maltreatment nodes to other nodes did increase in the high distress group. Also, physical neglect was connected to emotional neglect in the high distress group, but it was not connected to any other nodes in the low and moderate distress groups.

In all the distress groups, alcohol consumption and sociosexual orientation were positively associated with each other. This finding means that despite the level of sexual distress, a more severe or hazardous alcohol consumption was associated with a more unrestricted sociosexual orientation. This association was expected based on previous research (e.g., Halpern-Felsher, Millstein, & Ellen, 1996). Moreover, in the low distress group, alcohol consumption was positively associated with the FSF domain desire, meaning that a more severe alcohol consumption was associated with higher levels of sexual desire. This visual finding supports earlier research that has found a desire inducing effect of alcohol (George, 2019; Beckman & Ackerman, 1995). One potential explanation for the association between alcohol, desire and sociosexual orientation that other studies have observed that alcohol consumption can lead to a more impulsive and less inhibitory behavior, including

sexual behavior (Halpern et al., 1996). However, an interesting change happened in the moderate and high distress groups; the direct association between alcohol consumption and sexual desire disappeared. In these groups, alcohol consumption was positively associated with disordered eating instead. In other words, a high consumption of alcohol among women with moderate and high levels of sexual distress was associated with more disordered eating behavior. Despite these findings not being significant, these visual findings are in line with earlier research where alcohol consumption has repeatedly been linked with disordered eating behaviors (Dansky, Brewerton, & Kilpatrick, 2000; Giles, Champion, Suffin, McCoy, & Wagoner, 2009; O'Brien & Vincent, 2003). In these two groups with higher sexual distress, it was sociosexual orientation that was positively associated with FSF domain desire. These results could be interpreted to mean that the level of sexual distress could change the effects of alcohol consumption or disordered eating and how they affect sexual function. Due to the differencens not being significant a word of caution is in order. It is plausible that women who experience higher levels of sexual distress turn to alcohol or unhealthy eating behavior patterns in order to cope with the sexual distress and/or functioning problems. For example, as sexual distress increases it can cause women to develop disordered eating habits which could further lead to increased alcohol use. Conversely, the causality could be the other way around, that is, sexually distressed women consume more alcohol and develop disordered eating habits as a consequence of their increased alcohol consumption.

Finally, body dissatisfaction and sexual body image nodes were not directly associated with any of the sexual function nodes in any network, meaning that sexual distress didn't affect the relationship between these variables. In the low distress network, sexual body image was positively connected with body dissatisfaction and negatively associated with BMI. In the moderate and high distress networks sexual body image was positively associated solely with body dissatisfaction. The absence of associations between body

dissatisfaction and sexual functioning are in contrast to several studies that have found a link between body dissatisfaction and sexual functioning (Woertman & van den Brink, 2012; Afshari, Houshyar, Javadifar, Pourmotahari, & Jorfi, 2016). In these studies, dissatisfaction with one's body was negatively associated with sexual functioning. Additionally, Herbenik and colleagues (2011) have observed that positive attitudes and beliefs of one's genitals are associated with better sexual functioning. These studies point to a conclusion made by Daniluk (1993) that an experience of bodily acceptance is a critical factor in healthy sexual functioning. One potential explanation for this contradictory finding of the present study could be the fact that network analysis afforded me an opportunity to better control the many correlates associated with female sexual function. In line with this, it could be speculated that the association between body dissatisfaction and sexual functioning was absent due to the moderating effect of the other included variables. To our knowledge, the studies mentioned above that found an association between body dissatisfaction and sexual function did not include measures of for example depression or anxiety. In the present study, body dissatisfaction was connected to sexual satisfaction through depression in the high distress group. Another potential explanation to our result may be the fact that our measure on sexual body image had poor internal consistency (alpha = .41) and was not particularly well validated but we decided to include it because not many prior studies have differentiated between body dissatisfaction and sexual body image.

To conclude, some similarities considering two other network papers on female sexual function that used partially the same data as we did will be discussed (see; Gunst et al., 2018; Källström, Nickull, Gunst, & Jern, 2019). In both studies, sexual distress was more connected with the sexual satisfaction node than with the other sexual function nodes. Therefore, it was deemed that sexual distress was not only an aspect of sexual dysfunction. This finding was supported by our study, as sexual distress affected the number of edges

connected to the sexual satisfaction node. In women with low levels of sexual distress, sexual satisfaction was more strongly connected with the other sexual function variables. When sexual distress increased, the number of associations decreased (edges from sexual satisfaction to orgasm and lubrication disappeared). This can be interpreted so that sexual distress can have a limiting effect on how sexual satisfaction is associated with sexual function variables. The studies of Gunst and colleagues (2018) and Källström and colleagues (2019) also suggested that sexual distress functioned as a bridge node between sexual function and psychological distress nodes. In the present study, we observed that in the low distress group, sexual function variables had a stronger predictive effect on each other than in the high distress group (more edges among FSF nodes in the low group). This seems to indicate that sexual distress has a central role in female sexual functioning. However, as no significant differences between the networks were found, caution in these inferences is warranted. Speculatively speaking, our study seems to indicate that when sexual distress is high, there are some additional edges connecting psychological distress to the sexual function variables that are not present in the other networks (i.e., between depression and sexual satisfaction). These results give partial support to the bridge function of sexual distress hypothesis. The third similarity between our results and the two other studies was the fact that arousal was the most central node in all of the distress groups in all studies

Strengths and Limitations

Our study had several strengths. The present study is, to our knowledge, the first study to explore the role of sexual distress on the symptom interactions between identified correlates, such as female sexual function, psychological distress, childhood trauma and alcohol use. Additionally, we had a large data set to our disposal with a variety of variable measures, most with sound psychometrical properties. To our knowledge, no comparable data set exists that captures the variety of variables mentioned above. Our study is also one of the first studies

using network analysis to explore sexual distress in women. Network analysis afforded us to untangle the very complex conditional dependence relationships between different psychological variables with high intercorrelations, allowing for the development of more specific causal hypotheses to test for example with time-series design or other research designs which offer a possibility to isolate causal processes in a more effective way.

Despite the several strengths of our study, there were also some limitations. We analyzed cross-sectional between-person data and it can only be generalized to a certain degree. The generalizability of between-person results has been criticized due to the large variation between individuals and therefore we can not know if the same effects are valid intraindividually (Fisher, Medaglia, & Jeronimus, 2018). Our results speak primarily at the group level and they can only to a limited degree expand our understanding of how the psychological processes work within individuals. Additionally, the data pertains also only to one time point and we do not know how the variables affect each other over time. Because of these factors, any findings from our study need to be interpreted in context and one needs to be wary of overgeneralization and overinterpretation. To corroborate our findings and to decipher causal pathways between variables time series-based experience sampling methods (repeated observations from the same individual see; Epskamp et al., 2018) need to be used. The strength of cross-sectional between-person networks lie in their potential to gain a more detailed and in-depth view of comorbidities between different mental disorders and psychological phenomena (Bos et al., 2017). As these networks visualize complex partial correlational associations between variables, they can be used to gain insight of the predictive effects between variables. From a technical perspective, the networks presented in our study are not purely between-person networks. Cross-sectional between-person network models combine between-person predictive effects as well as within-person predictive effects. Both trait- and state-level variation have an effect on our data, and it is difficult to distinguish them

from each other. Therefore, it is plausible to assume that some findings might be valid even in a time-series network, due to the finding's trait-level nature (Epskamp et al., 2018).

Another limitation of the present study pertains to the fact that some potentially relevant factors were left out of the analysis due to not having collected data on them in the original data collection. This limitation not only pertains to our study but also more generally to the network theory and network analysis. Variable selection is a critical aspect of network analysis and especially important in psychological networks as the etiology of different psychological disorders are not clear cut. The exclusion or inclusion of variables has the possibility to shape the network structure and affect the estimated partial correlations between different variables. In our study several factors relating to relationship quality, partner communication or relationship satisfaction were not available to be included in the present study. We had an option to include a variable on sexual compatibility but due to the binary nature of the variable we decided against including it. These limitations concerning the included variables inhibit the overall scope of our networks due to the fact that all above-mentioned factors have been identified as potential predictors of sexual functioning and sexual distress among couples (Hällström & Samuelsson, 1990; Witting et al., 2008). Future network studies should be aimed at including relationship factors in their analyses in order to obtain a clearer picture of how they affect the psychological dynamics of sexual function and sexual distress.

The matter of reliability of some of our measures is also important to point out. For example, we measured sexual body image by using two items from the Derogatis Sexual Function Inventory (DSFI) and created a composite variable based on them. As expected, the composite variable consisting of only two items had poor internal consistency (alpha = .41). This raises questions regarding the consistency of the measure and make inferences regarding the sexual body image composite variable questionable. However, in the context of the study,

examining female sexual function, we decided against erasing the variable from our analyses as we deemed it important to differentiate between overall body image and sexual body image. We deemed sexual body image an important variable because data of it is very rarely included in similar studies, even though some results point out that attitudes towards one's own genitals and attributes (primary and secondary) may in fact be very important in the context of female sexual function (Herbenik et al., 2011; Daniluk, 1993). Additional reasoning for using DSFI specifically was that alternative measures with more consistent and psychometrically more robust measurements tools are lacking.

Swedish summary

Nätverksanalys av kvinnors sexuella funktionsförmåga:
Jämförelse av symptomnätverk hos kvinnor med hög, moderat och låg sexuell ångest

Inledning

Hög sexuell funktionsförmåga har kopplats till bättre hälsa, relationstillfredställelse och livskvalitet (Witting et al., 2008; Lauman et al., 2006; Davison, Bell, LaChina, Holden, & Davis, 2009). Trots det är kvinnlig sexuell funktionsförmåga inte tillräckligt undersökt och problem relaterade till kvinnlig sexuell dysfunktion är prevalenta och upplevs som ett belastande problem bland många kvinnor (Burri & Spector, 2011; Shifren, Monz, Russo, Segreti, & Johannes, 2008; Witting, 2008).

Ungefär 40 % (McCool., 2016) av kvinnorna upplever problem i någon aspekt av sin sexuella funktionsförmåga medan ca 7–23 % av kvinnorna (Burri & Spector, 2011; Shifren et al., 2008; Witting, 2008) upplever explicit sexuell ångest (eng. sexual distress) på grund av nedsatt funktionsförmågan. Trots detta, finns det inga välkända orsaker varför en del kvinnor upplever sina funktionsproblem som ångestväckande, medan andra inte gör det. Sexuell ångest är ett centralt kliniskt symptom på grund av att det kan motivera de som lider av det att uppsöka behandling (t.ex. sexterapi). Utan en subjektiv upplevelse av ångest eller oro kan det upplevas onödigt att uppsöka behandling.

Syftet med den här studien är att undersöka hur upplevelsen av sexuell ångest påverkar kvinnors sexuella funktionsförmåga och andra relevanta samband. För att undersöka ämnet kommer en ny forskninsmetod användas, i form av en nätverkanalys. Tre nätverk bestående av hög, moderat och låg nivå av sexuell ångest kommer att estimeras och analyseras.

Kvinnlig sexuell funktion och sexuell ångest

Kvinnlig sexuell funktionsförmåga hänvisar till aspekter i kvinnors sexuella responscykel och innefattar följande kategorier: sexuell lust, sexuell upphetsning, lubrikation, förmåga att uppnå orgasm, avsaknad av oönskad smärta vid sexuell aktivitet och tillfredställelse över sexlive (Rosen et al., 2000). Då sexuella funktionsproblem väcker sexuell ångest, är det möjligt att erhålla diagnosen ”kvinnlig sexuell funktion” (American Psychological Association, 2013). Sexuell ångest avser upplevelser av ångest, oro eller negativa känslor gentemot den egna sexualiteten eller sexlivet (Derogatis, Rosen, Leiblum, Burnett, & Heiman, 2002; Meson & Trapnell, 2005).

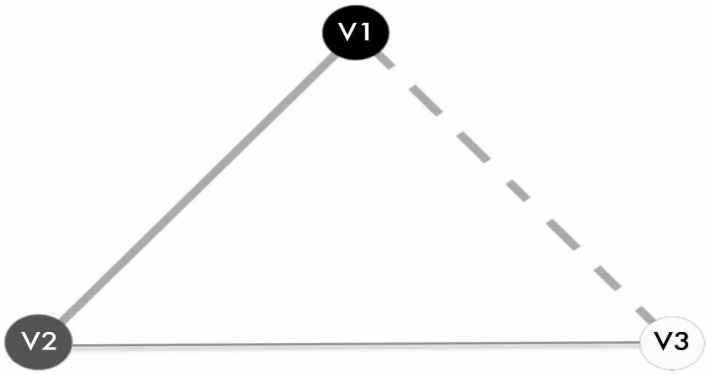
En av de centrala utmaningarna inom forskningsfältet har varit att förstå relationen mellan kvinnlig sexuell funktionsförmåga, kvinnlig sexuell dysfunktion och sexuell ångest. Ett flertal studiers resultat har påvisat att sexuell ångest kan förekomma antingen samtidigt med sexuella funktionsproblem eller oberoende av dem (King, Holt, & Nazareth, 2007; Rosen et al., 2009; Stephenson & Meston, 2012). Genetiska faktorer förklarar enbart en del (46 %) av variationen mellan individer. Detta har motiverat forskare att undersöka olika miljöfaktorer och dessa studier visar att vissa faktorer kan förmedla relationen mellan sexuell funktionsförmåga och sexuell ångest. Till dessa faktorer hör: depression och ångest (Hayes et al., 2008), dysfunktionella ätbeteenden (Dunkley, 2015) och barndomstrauman (Stephenson & Meston, 2015).

Kvinnliga sexuella dysfunktioner tenderar att samexistera och ökar även risken för andra problem, såsom depression (Lauman et al., 1999; Shifren et al., 2008), ångest (Pinheiro et al., 2010), missnöje i parrelationer (Witting et al., 2008), ätstörningar (Castellini et al., 2012) och kroppsmissnöje (Woertman & van den Brink, 2012). Många av de faktorer som är associerade med kvinnliga sexuella dysfunktioner är också associerade sinsemellan:

depression och kroppsmissnöje (Flores-Cornejo, Kamego-Tome, Zapata-Pachas, & Alvarado, 2016), depression och ätstörningar (Manaf, Saravanan, Zuhrah, 2016) samt depression och barndomstrauma (Gerke et al., 2018). På grund av det här har det varit svårt att klargöra relationen mellan de olika faktorerna och deras påverkan på kvinnors sexuella funktionsförmåga. Med hjälp av nätverksanalys är det möjligt att skapa en mer komplex modell där många av de identifierade variablerna kan inkluderas och kontrolleras för.

Nätverksanalys

Nätverksanalys erbjuder ett nytt sätt att konceptualisera psykopatologi som dynamiska symptomnätverk, där olika symptom (studievariabler) är i direkt interaktion med varandra (Borsboom, 2017). Nätverksanalys går ut på att estimera nätverk, där uppmätta psykologiska symptom och andra variabler (t.ex. ålder eller kroppsmasseindex) är representerade som noder (eng. nodes) i nätverket. Associationer mellan olika noder är representerade med kopplingar (eng. edges), som i nätverk baserade på data mellan olika individer oftast är korrelationer eller partiella korrelationer (se Figur 1 för ett exempel på ett nätverk).



Figur 1. Exempel på en hypotetisk nätverksstruktur mellan tre variabler (V1, V2, V3). Noderna (cirklarna) representerar variabler och strecken (kopplingarna) mellan noderna representerar partiella korrelationer. Solida linjer representerar positiva korrelationer och streckade linjer representerar negativa korrelationer. Tjockheten av linjerna visualiserar korrelationens styrka. Därmed är till exempel kopplingen mellan V2 och V1 starkare än kopplingen mellan V2 och V3.

Grunden i nätverksperspektivet är att mentala störningar uppstår på grund av kausala samband mellan symptom och att symptomen är kopplade till varandra genom en mångfald av biologiska, psykologiska och sociala faktorer (Borsboom, 2017). Exempelvis kan depression från detta perspektiv konceptualiseras som slutstadiet av växelverkan mellan dessa ovannämnda faktorer. En stressfull livssituation (t.ex. skilsmässa) kan försämra förmågan att sova, vilket kan leda till sämre arbetsprestation och orsaka känslor av nedstämdhet och värdelöshet, vilket ytterligare kan försämra förmågan att sova och vidare förvärra upplevelsen av nedstämdhet eller depression. På detta sätt kan symptom skapa (negativa) återkopplingsslingor med varandra och orsaka ett patologiskt tillstånd, där olika symptom upprätthåller varandra trots att det ursprungliga symptomet eller händelsen (den stressiga livssituationen) är över. Nätverk varierar i hur motståndskraftiga eller sårbara de är.

Det här beror på att olika nätverk varierar i hur starka kopplingar olika symptom har till varandra. I sårbara nätverk finns det flera starka kopplingar mellan variablerna, vilket gör att variablerna kan påverka varandra i högre grad. På grund av det kan aktiveringen av enstaka symptom (t.ex. en sömnlös natt) sätta igång en dominoeffekt av aktivering som sprider sig genom hela nätverket. I mer motståndskraftiga nätverk finns det färre starka band mellan noderna och aktiveringen av enstaka symptom har inte tillräckligt med styrka att sätta igång dominoeffekten. Noder med starka kopplingar till varandra har också en tendens att forma nodgrupper (eng. communities). Detta kallas för nätverksfragmentering, och i sårbara nätverk finns det färre och större nodgrupper medan mer motståndskraftiga nätverk har ett flertal små nodgrupper.

Syfte och hypoteser

Syftet med den här avhandlingen är att utnyttja ny forskningsmetodologi, i form av nätverksanalys, för att undersöka hur sexuell ångest påverkar kvinnors sexuella funktionsförmåga. Tre symptomnätverk för kvinnor med låg, moderat och hög nivå av sexuell ångest estimerades och analyserades. Utöver sexuell funktionsförmåga inkluderade nätverken mått på depression, ångest, barndomstrauma, alkoholkonsumtion, missnöje med kroppen, sociosexualitet och BMI.

Följande hypoteser testades:

1) Strukturen i symptomnätverk hos kvinnor som upplever högre nivåer av sexuell ångest skiljer sig från kvinnor som upplever lägre nivåer av sexuell ångest.
2) Kvinnor med högre nivåer av sexuell ångest uppvisar starkare positiva samband med negativt värderade variabler (t.ex. depression, ångest och sexrelaterad smärta).
3) Kvinnor med lägre nivåer av sexuell ångest uppvisar starkare positiva samband mellan positivt värderade variabler (t.ex. sexuell tillfredställelse och orgasmfunktion).

4) De icke-sexrelaterade negativt värderade variablerna (t.ex. depression, ångest och kroppsmissnöje) visar mer negativa samband med FSF-noderna i gruppen med höga nivåer av sexuell ångest.
5) Nätverket med höga nivåer av sexuell ångest uppvisar mindre fragmentering och bildar ett färre antal större nodgrupper än nätverken med lägre nivåer av sexuell ångest.

Utöver dessa hypoteser hade studien också explorativa syften, som att undersöka ifall vissa kopplingar var viktigare än andra och identifiera de mest centrala noderna i nätverken. Detta gjordes i hopp om att utvidga förståelsen för de komplexa kopplingarna av de inkluderade variablerna och för att främja skapandet av nya hypoteser för framtida forskning.

Metod

Deltagare och mått

Samplet för den här studien bestod av 3 144 finska kvinnor mellan 18 och 49 år som deltog i en finsk populationsbaserad enkätundersökning. Data som använts i studien samlades under den första datainsamlingen år 2006 (the Genetics of Sexuality and Aggression study; se Johansson et al., 2013). Det ursprungliga samplet bestod av 6 215 kvinnliga tvillingar och systrar till tvillingar. Eftersom sexuell funktion kan variera beroende på om en person är i ett förhållande eller inte, och problem inom sexuell funktion tenderar att uppstå inom långa parförhållanden, fattades beslutet att enbart inkludera kvinnor som var i ett förhållande. Samplet bestod då av 4 694 kvinnor. För att undvika uppkomsten av systematiska fel orsakade av genetiskt släktskap utfördes ytterligare exkluderingar och samplet bestod då av 3 281 kvinnor. Eftersom nätverksanalyser kan påverkas av ojämna grupper delades kvinnorna in i tre lika stora undergrupper (låg, moderat och hög) som bestod av 1 048 deltagare var,

vilket ledde till det slutliga samplet på 3 144 deltagare. Deltagarnas skriftliga samtycke erhölls och Åbo Akademis forskningsetiska nämnd godkände studiens forskningsplan.

Tre lika stora ångestgrupper skapades genom att dela in deltagarna enligt svaren de angett i ”Female Sexual Distress Scale” (FSDS; Derogatis, Rosen, Leiblum, Burnett, & Heiman, 2002). Tre olika nätverk estimerades på basis av denna gruppindelning. Varje nätverk innehöll totalt 19 olika variabler. Sex variabler relaterad till kvinnlig sexuell funktion inkluderades: sexuell lust, upphetsning, lubrikation, förmåga att nå orgasm, avsaknad av oönskad smärta vid sexuell aktivitet och tillfredställelse med sexlivet (Female Sexual Function Index [FSFI]; Rosen et al., 2000). Fem variabler relaterade till barndomstrauma inkluderades: känslomässiga övergrepp, fysiska övergrepp, sexuella övergrepp, känslomässig försummelse och fysisk försummelse (Childhood Trauma Questionnaire [CTQ]; Bernstein & Fink, 1997). Fem variabler för psykiskt mående (ångest, depression, dysfunktionellt ätbeteende, kroppsmissnöje och missnöje med det egna könsorganets utseende) inkluderades. (Derogatis Sexual Function Inventory [DSFI]; Derogatis & Melisaratos, 1979). En variabel för sociosexualitet (Sociosexual Orientation Inventory [SOI]; Simpson & Gangestad, 1991) och en variabel för deltagarnas alkoholkonsumtion (Alcohol Use Disorder Identification Test [AUDIT-C]; Babor, Higgins-Biddle, Saunders, & Monteiro) inkluderades. Dessutom inkluderades en variabel för BMI (Body-Mass Index [BMI]; WHO, 2019).

Statistiska analyser

De statistiska analyserna, nätverksestimeringarna och nätverksvisualiseringarna utfördes med R 3.5.2 (R Core Team, 2018) med paketen *bootnet* (Epskamp et al., 2017), *qgraph* (Epskamp et al., 2018), *NetworkComparisonTest* (van Borkulo et al., 2017) och *igraph* (Csárdi & Nepusz, 2014) på RStudio version 1.2.335 för Mac.

Tre partiella korrelationsnätverk estimerades, vilka är en typ av ”Gaussian graphical model” eller GGM-nätverk. I ett GGM-nätverk representeras olika mätbara variabler som noder i nätverket. Statistiska associationer mellan olika noder representeras av streck mellan noderna som kallas för kopplingar. Då partiella korrelationsnätverk estimeras, förekommer det en risk för att falska kopplingar ska uppstå mellan noder på grund av variation i urvalet. Regulariseringstekniker används för att minska risken för dessa falska kopplingar, och för att säkerställa estimeringen av ett så robust och pålitligt nätverk som möjligt. De vanligaste regulariseringsmetoderna för partiella korrelationsnätverk användes, vilket är ”graphical lasso”-regularisering i kombination med ”EBIC model selection”.

Fruchterman-Reingold-algoritmen användes för att visualisera nätverken. Algoritmen fungerar enligt principen att noder som är starkt kopplade till varandra dras till varandra, medan noder som är svagt kopplade till varandra stöts bort från varandra. Nätverken jämfördes statistiskt med varandra för att undersöka om nätverken skiljde sig åt i struktur eller kopplingarnas totala styrka. Utöver detta undersöktes även centraliteten av variabler, det vill säga om vissa variabler var mer relevanta än andra. Till sist undersöktes fragmenteringen av nätverken för att se om nätverken skiljde sig åt i hur de bildade nodgrupper.

Resultat

Figur 1 (s. 26) visar alla tre nätverk. Mängden kopplingar varierade mellan 21 och 24. Moderata nätverket hade minsta mängden kopplingar (21 st.), låga nätverket hade den näst minsta mängden (23 st.) och höga nätverket hade mest kopplingar (24 st.). De tre nätverken hade generellt likartade strukturer, och många samma kopplingar förekom i alla tre nätverk. De estimerade kopplingarna var till största del av samma styrka och riktning.

Den statistiska jämförelsen mellan nätverken påvisade inga signifikanta skillnader mellan nätverken. Nätverken var statistiskt sett lika gällande struktur (hög vs moderat p = 0,07, låg vs hög p = 0,19, låg vs moderat p = 0,93) och kopplingarnas totala styrka.

Mängden kopplingar mellan noder som mätte sexuell funktion varierade som funktion av sexuell ångest. Kopplingarna mellan noderna var för det mesta positiva, vilket innebar att höga värden inom ett område av sexuell funktion även var kopplade till höga värden inom ett annat.

Noder som relaterade till sexuell funktion och psykisk hälsa (depression, ångest, ätstörningssymptom och kroppsmissnöje) hade kopplingar till varandra bara i höga och låga nätverken. Sexuell lust hade en positiv koppling till ätstörningssymptom i det låga nätverket, vilket tyder på att kvinnor med låg nivå av sexuell ångest hade en tendens att rapportera hög nivå av sexuell lust i kombination med hög nivå av ätstörningssymptom. Sexuell tillfredställelse hade en negativ koppling till depression i det höga nätverket: bland kvinnor med hög nivå av sexuell ångest, var en hög nivå av sexuell tillfredställelse associerat med få depressionssymtom.

Noderna för sexuell funktion och barndomstrauma hade inga kopplingar mellan varandra i någondera av nätverken. Bristen på kopplingar mellan noderna innebar att sambandet mellan sexuell funktion och barndomstrauma inte kunde förklaras av varierande nivåer av sexuell ångest.

Nätverken uppvisade olika nivåer av nätverksfragmentering. Mängden nodgrupper och nodgruppernas innehåll varierade mellan varje nätverk. Både låga nätverket och moderata nätverket hade båda sju nodgrupper, medan den höga nätverken hade fyra nodgrupper (se Figur 3 sida 29).

Diskussion

Syftet med den här studien var att estimera och analysera hur varierande nivåer av sexuell ångest påverkar nätverk bestående av variabler på kvinnors sexuella funktioner och andra identifierade korrelat. Tre olika mellanindividnätverk för kvinnor som rapporterade låg, moderat och hög nivå av sexuell ångest estimerades. Resultaten gav inte stöd för de första fyra hypoteserna, eftersom inga signifikanta skillnader mellan de tre nätverken upptäcktes, varken på strukturell- eller styrkenivå mellan alla kopplingar. Resultaten angående nätverksfragmenteringen stödde däremot den femte hypotesen, i och med att det höga nätverket bildade färre nodgrupper (4 stycken) i jämförelse med moderat och låg nätverket (7 stycken var). Resultaten antyder att det höga nätverkets noder var mer starkt kopplade till varandra, vilket gjorde att hela nätverket också var mer sårbart för symptomaktivering. Dessa symptomassociationer är dock baserade på tvärsnittsdata mellan olika individer. Om man antar att samma associationer skulle gälla på individnivå, skulle det betyda att kvinnor som upplever högre nivåer av sexuell ångest har ett mer sårbart nätverk och aktiveringen av ett enskilt symptom kan orsaka en våg av ytterligare symptomaktivering och påverka nätverket i sin helhet. Kvinnor med låg nivå av sexuell ångest skulle därmed vara mer motståndskraftiga för symptomaktivering och enskilda noder skulle inte kunna i samma grad förorsaka en våg av aktivering i nätverket.

Trots att nätverken inte hade signifikanta skillnader sinsemellan, förekom det vissa observationer som är värda att poängtera. För det första framkom det en negativ koppling mellan depression och sexuell tillfredställelse i det höga nätverket som inte förekom i de andra nätverken. Detta kan tyda på att sambandet mellan sexuell tillfredställelse och depression förmedlas av sexuell ångest. Det kan antingen betyda att kvinnor som samtidigt upplever en hög nivå av sexuell ångest i kombination med depression kan ha en förminskad

förmåga att uppleva sexuell tillfredställelse, eller att kvinnor som har hög nivå av sexuell ångest och låg nivå av sexuell tillfredställelse har en högre sannolikhet att utveckla depressiva symptom.

För det andra är det värt att nämna att noderna för sexuell funktion och barndomstrauma inte hade kopplingar till varandra i något av nätverken. I ljuset av tidigare studier, som undersökt relationen mellan sexuell funktion och barndomstrauma och funnit samband mellan dem, är det överraskande att dessa variabler inte hade kopplingar till varandra i mina nätverk. Eftersom variablerna inte var kopplade till varandra (trots att inflytandet av diverse variabler kontrollerades såsom depression, ångest, alkoholkonsumtion och sociosexualitet) och kopplingarna var frånvarande i alla tre nätverken, verkar det som att resultaten inte var förmedlad av sexuell ångest. Tidigare studier har till exempel observerat att relationen mellan sexuella funktioner och sexuell ångest modereras av sexuell misshandel i barndomen (Stephenson & Meston, 2011). Orsaken till bristen på kopplingar mellan variablerna härstammar antagligen från faktumet att den använda modellen inte var tillräckligt komplex. Därtill förklaras relationen mellan barndomstrauma och sexuella dysfunktioner troligen av faktorer som inte inkluderades i vår modell.

Studien bestod av såväl styrkor som svagheter. Den här studien är en av de första som undersöker rollen av sexuell ångest på symptominteraktioner för kvinnors sexuella funktionsförmåga och andra relevanta korrelat. Därtill utfördes studien utgående från en omfattande datafil som bestod av en mångfald av variabler med stabila psykometriska egenskaper. Till studiens svagheter hör att den baserade sig på tvärsnittsdata som samlades in av ett flertal individer, vilket gör det svårt att dra några kausala slutsatser utgående från resultaten. Studiens resultat gäller enbart på gruppnivå och kan endast i en begränsad utsträckning utvidga vår förståelse av psykologiska processer hos individer. Utförande av tidsseriebaserade nätverksstudier skulle vara av största vikt för att klargöra riktningen på

kausala samband. På grund av urvalet av nätverkens inkluderade variabler, förekom även en generell svaghet i alla nätverksanalyser. Valet av variabler är en avgörande faktor i nätverksanalyser och är speciellt viktigt vid estimering av psykologiska nätverk, då etiologin för olika psykologiska störningar inte är entydiga. Variabler relaterade till parförhållandets kvalitet, kommunikation mellan partner och tillfredställelse i parförhållandet var inte tillgängliga i denna studie och kunde därför inte inkluderas. Variabler relaterade till parförhållanden har i tidigare studier påvisats vara kopplade till sexuell funktion och sexuell ångest bland partner (Hällström & Samuelsson, 1990; Witting., et al., 2008).

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APPENDIX

Appendix

Table of Contents

1 Network Accuracy and Stability

1.1 Centrality Stability

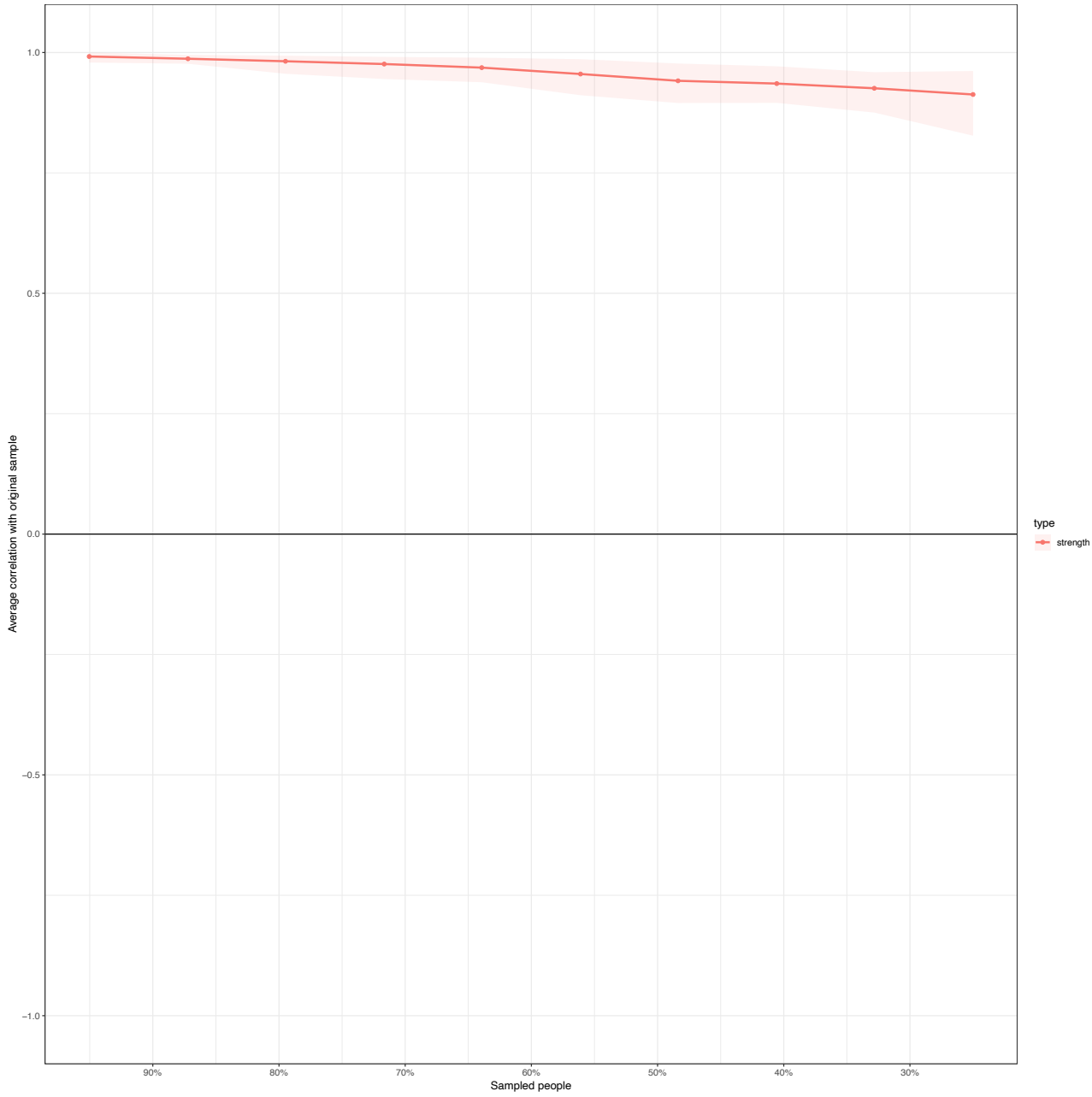

Figure 6. Bootstrapped strength stability plot for women with high sexual distress. Figure presents average strength centrality correlation between the dropped bootstrap samples and the original sample. The red line indicates the means and the lighter red shadow area is an indication of the range from the 2.5th quantile to the 97.5th quantile.

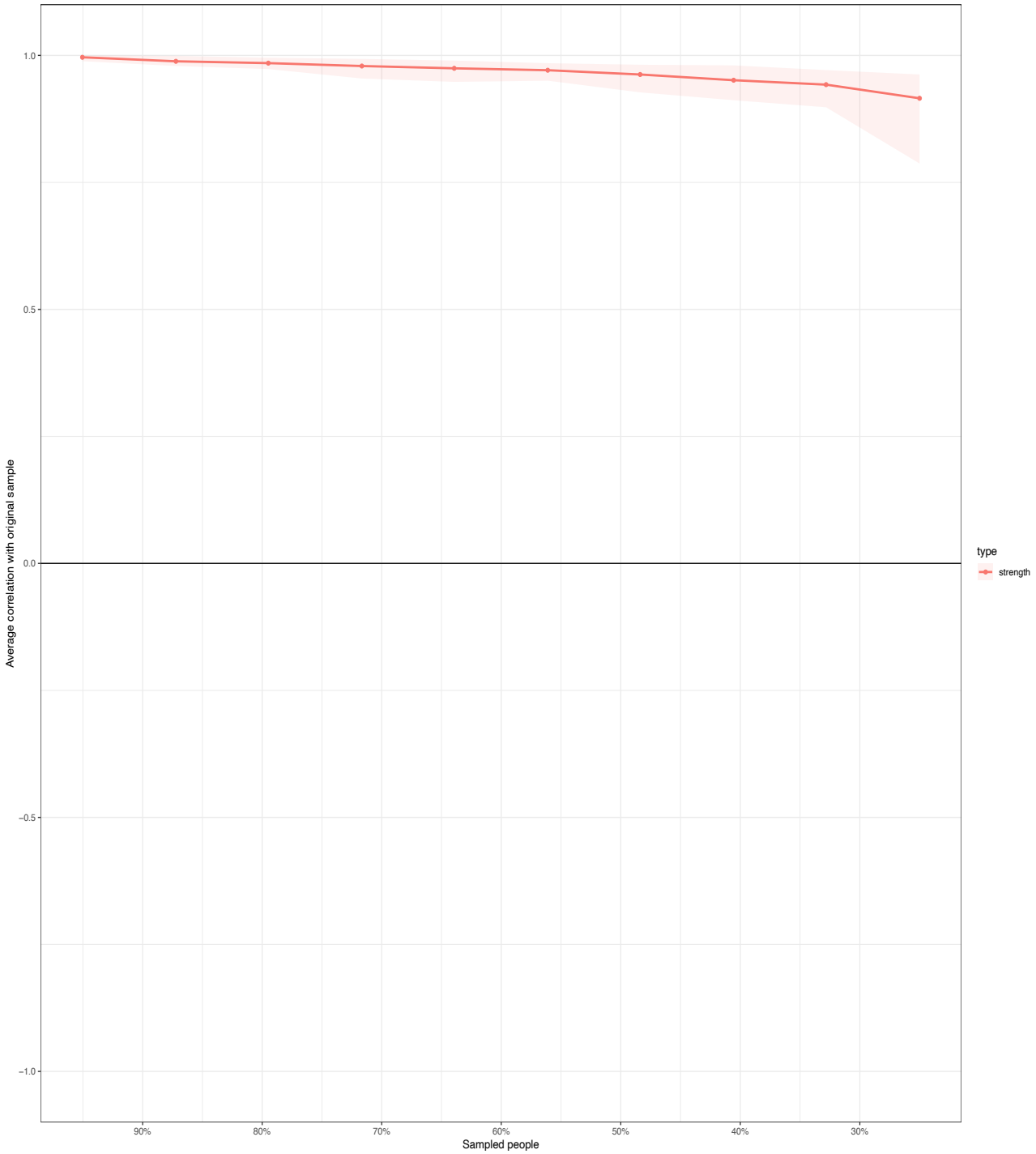

*Figure 6*a. Bootstrapped strength stability plot for women with moderate sexual distress. Figure presents average strength centrality correlation between the dropped bootstrap samples and the original sample. The red line indicates the means and the lighter red shadow area is an indication of the range from the 2.5th quantile to the 97.5th quantile.

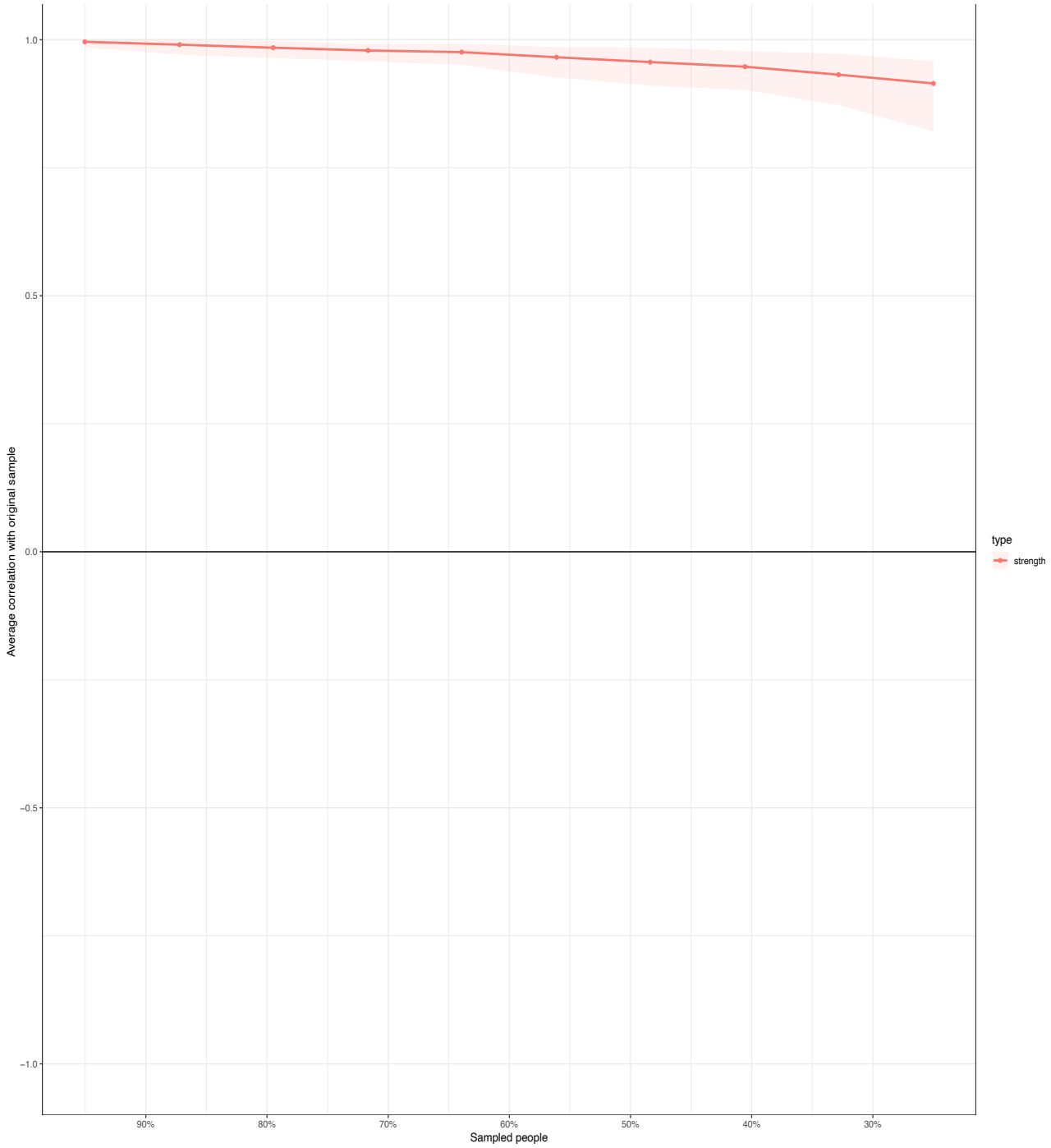

Figure 6b. Bootstrapped strength stability plot for women with low sexual distress. Figure presents average strength centrality correlation between the dropped bootstrap samples and the original sample. The red line indicates the means and the lighter red shadow area is an indication of the range from the 2.5th quantile to the 97.5th quantile.

1.2 Bootstrapped Edge-weights

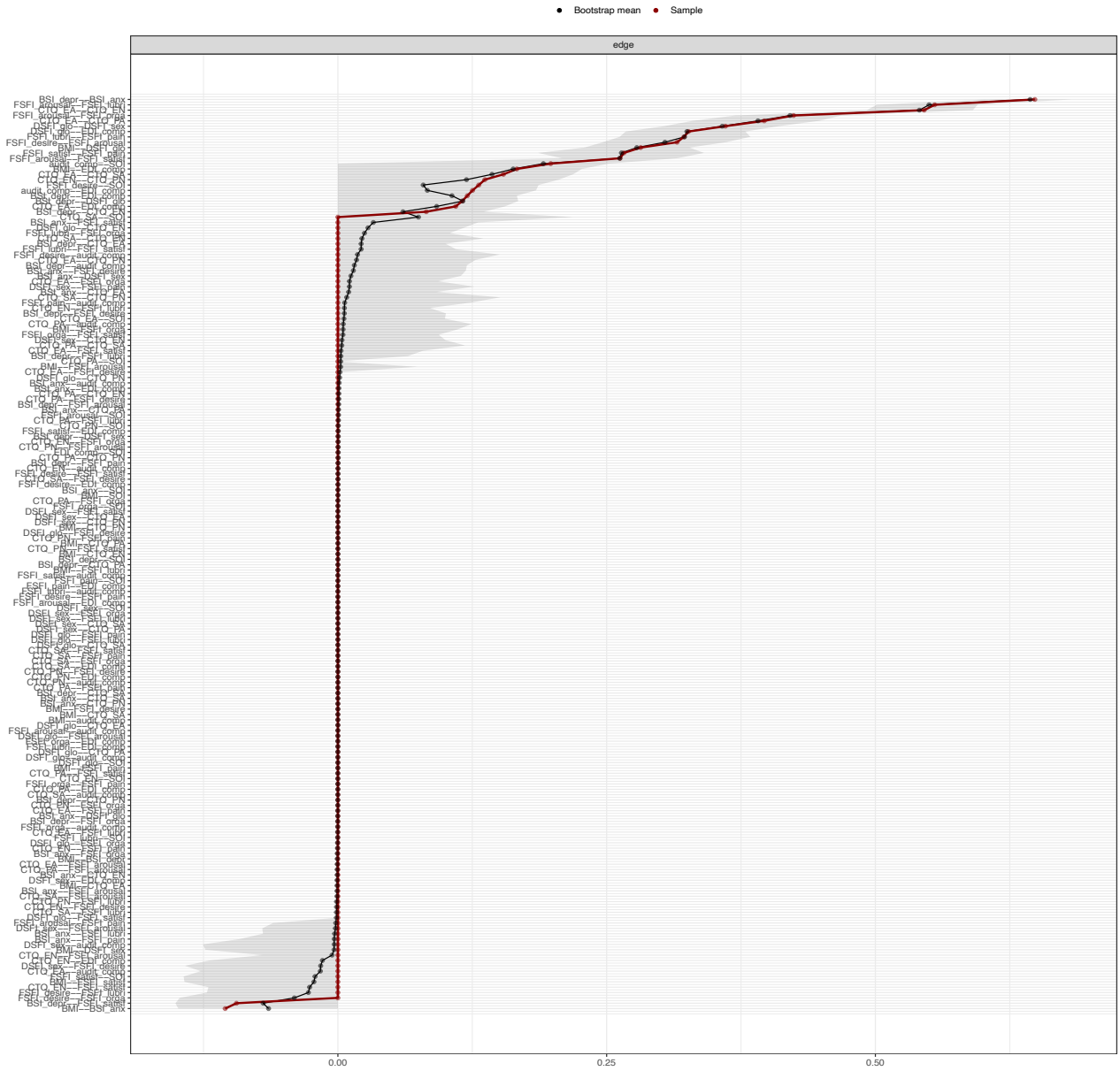

Figure 7. Bootstrapped confidence intervals of estimated edge-weights edge for women with high sexual distress. The red line is an indication of the sample value and the gray area is an indiction of the bootstrapped CIs. Y-axis presents all zero and non-zero edges in the network.

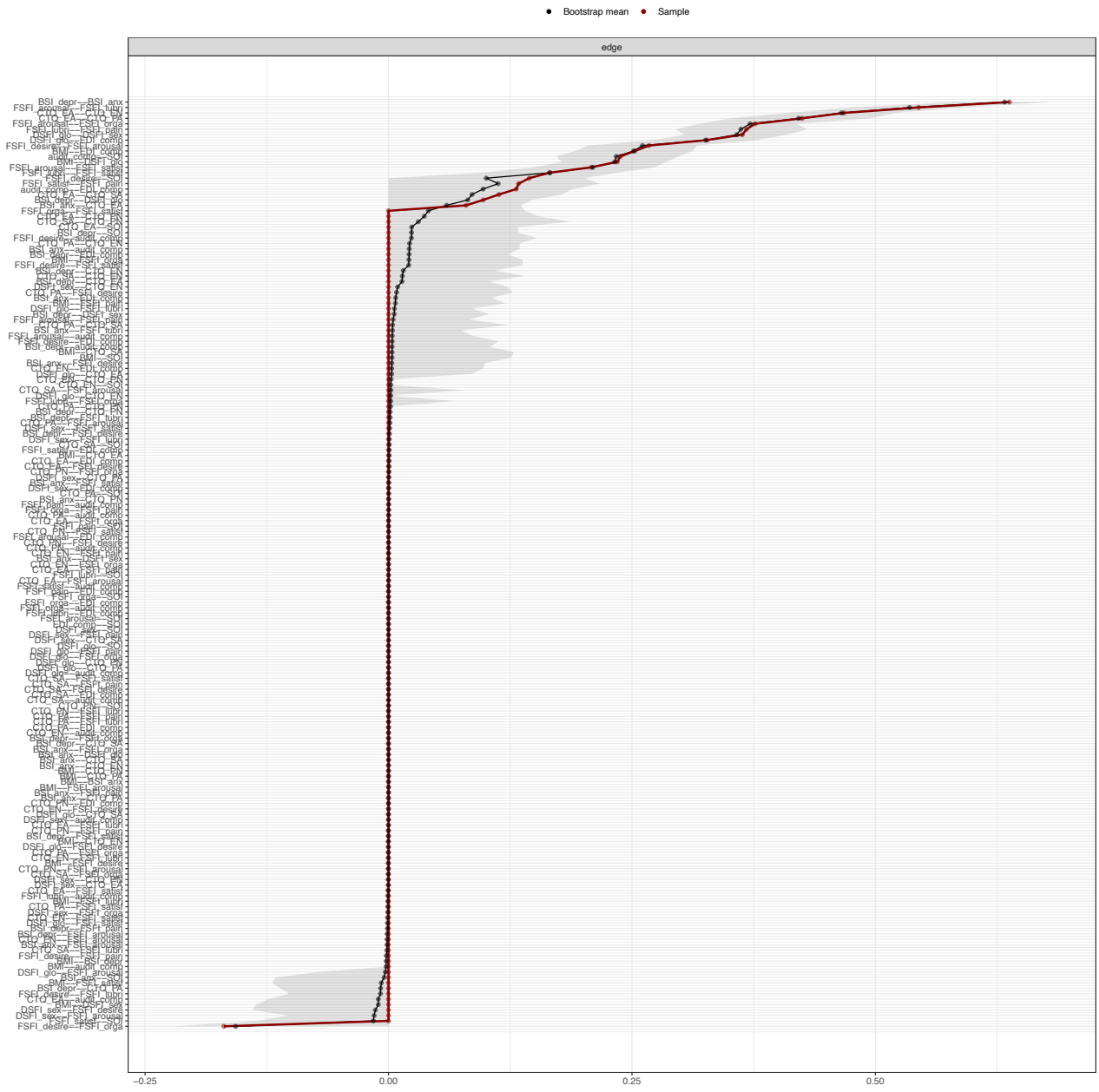

Figure 7a. Bootstrapped confidence intervals of estimated edge-weights edge for women with moderate sexual distress. The red line is an indication of the sample value and the gray area is an indiction of the bootstrapped CIs. Y-axis presents all zero and non-zero edges in the network.

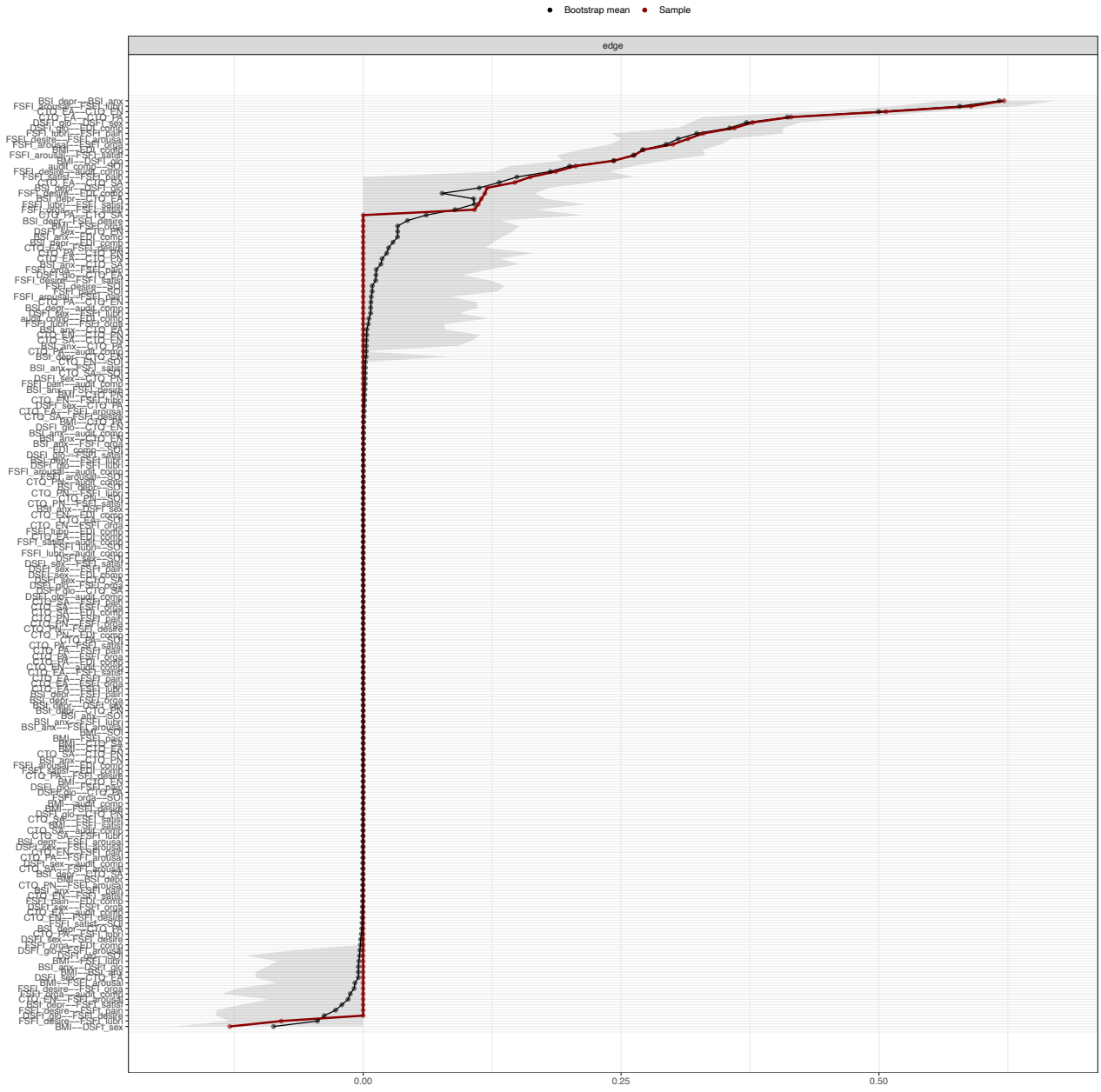

Figure 7b. Bootstrapped confidence intervals of estimated edge-weights edge for women with low sexual distress. The red line is an indication of the sample value and the gray area is an indiction of the bootstrapped CIs. Y-axis presents all zero and non-zero edges in the network.

2 Network Significance

2.1 Edge-weight significance plots

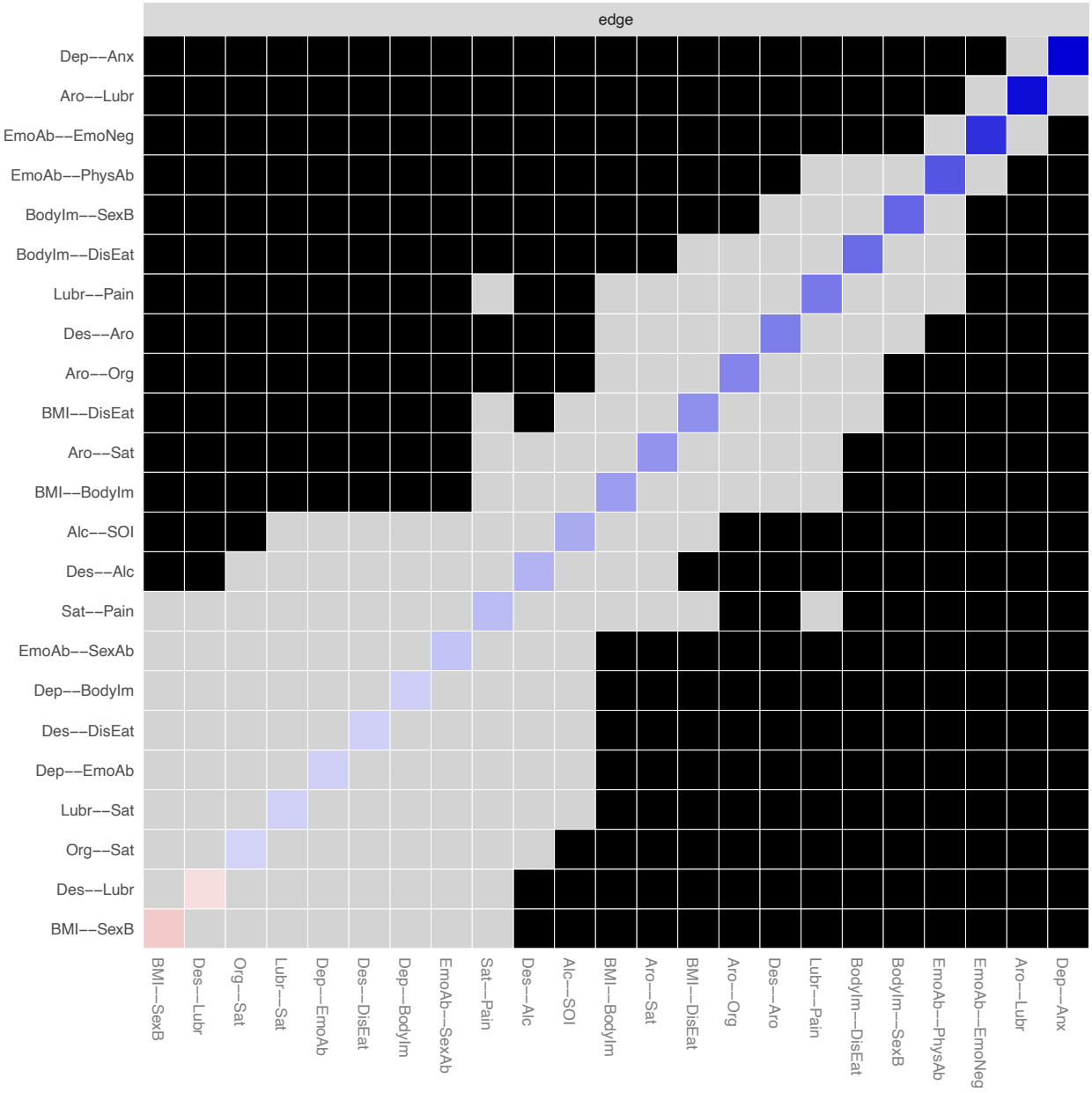

Figure 8. Edge-weight significance plot women with low distress. Grey boxes represent non-significantly different edges and black boxes represent significantly different edges.

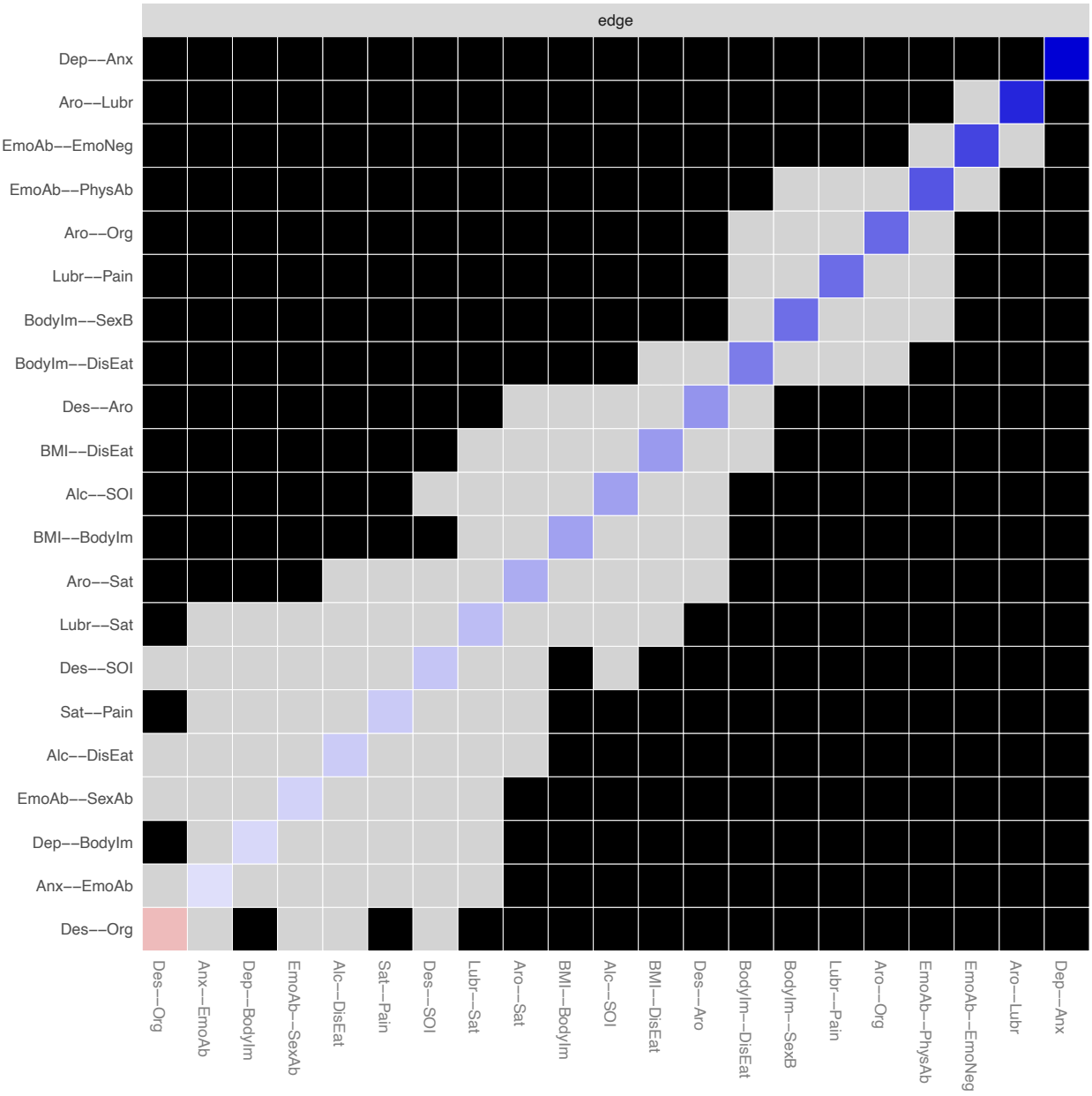

Figure 8b. Edge-weight significance plot for women with moderate distress. Grey boxes represent non-significantly different edges and black boxes represent significantly different edges.

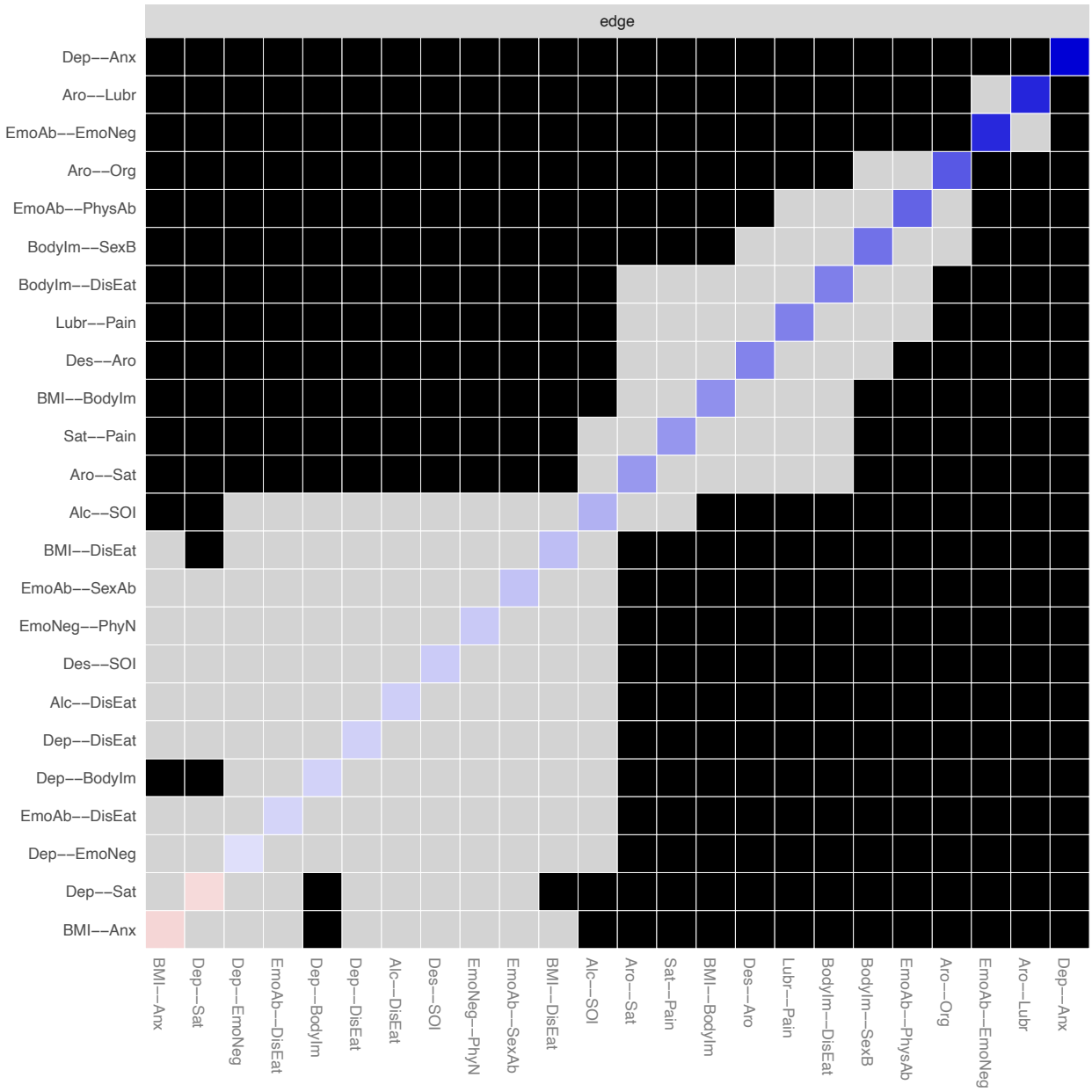

Figure 8c. Edge-weight significance plot for women with high distress. Grey boxes represent non-significantly different edges and black boxes represent significantly different edges.

3 Network communities

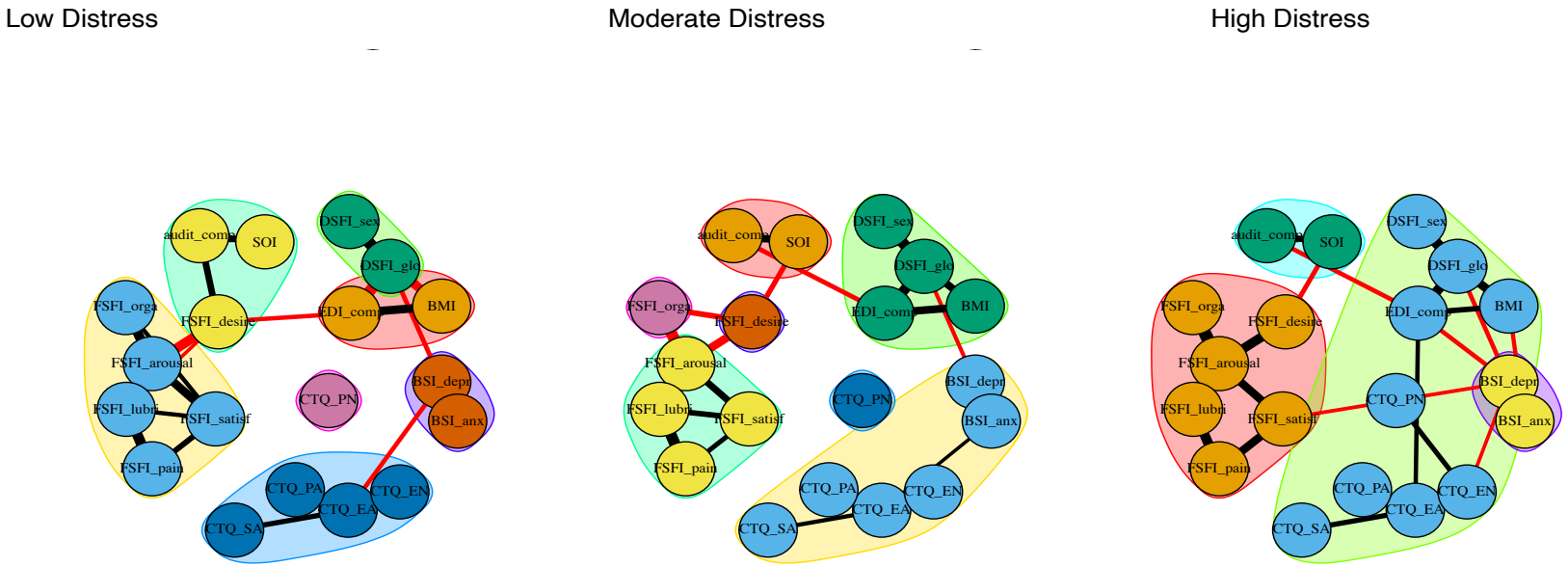

Figure 2A. Node communities for the three distress Gaussian graphical model (GGM) networks presented in Figure 1. Communities are based on the walktrap algorithm and are represented as nodes inside distinct clouds. The both the low and moderate distress group shows seven communities and the high distress group shows four communities. FSFI_orga = orgasm, FSFI_arousal = arousal, FSFI_lubri = lubrication, FSFI_satisf = sexual satisfaction, FSFI_pain = sexual related pain, FSFI_desire, CTQ_SA = sexual abuse, CTQ_PA = physical abuse, CTQ_EA = emotional abuse, CTQ_EN = emotional neglect, CTQ_PN = physical neglect, BSI_anx = anxiety, BSI_depr = depression, audit_comp = (hazardous) alcohol use, SOI = sociosexual orientation, DSFI_sex = sexual body image, EDI_comp = disordered eating, BMI = body mass index.

PRESSMEDDELANDE

Nätverksanalys av kvinnors sexuella ångest: Jämförelse av symptomnätverk hos kvinnor med hög, moderat och låg nivå av sexuell ångest

Pro gradu-avhandling i psykologi
Fakulteten för humaniora, psykologi och teologi, Åbo Akademi

Nätverksanalys är en ny teori och forskningsmetod som fått fotfäste inom psykologisk forskning under de senaste åren. Nätverksanalysen påstår att mentala mentala störningar uppstår på grund av kausala samband mellan biologiska, psykologiska och sociala faktorer. I nätverksanalys konceptualiceras psykiska störningar (t.ex. depression) som aktiverade tillstånd av nätverk som består av olika symtom som påverkar varandra (i depression t.ex. irritabilitet, nedstämdhet och minskad aptit). Nätverskanalysen hävdar att aktiveringen av ett symtom (t.ex. irritabilitet) kan också aktivera andra symtom (t.ex. minskad aptit och nedstämdhet) och därmed orsaka ett mer patologiskt tillstånd (t.ex. depression). Aarno Rekola utnyttjade nätverksanalys i sin Pro gradu-avhandling i psykologi vid Åbo Akademi för att undersöka hur sexuell ångest påverkar kvinnlig sexuell funktionsförmåga.

Studiens resultat visade att kvinnor som upplevde högre nivåer av sexuell ångest hade en mer sårbar nätverksstruktur, det vill säga att hela nätverket kunde lättare hamna i ett patologiskt tillstånd. Trots det var skillnaden mellan nätverken liten. Problem med sexuell upphetsning var det mest inflytelserika symptomen i alla tre nätverk. Det tyder på att det kan vara värt att försöka behandla problem i sexuell upphetsning då man planerar behandling för sexuella problem hos kvinnor.

Sampeln bestod av 3 144 kvinnors svar på en enkät som innehöll mått på sexuell funktionsförmåga och andra relaterade faktorer. Data som användes i studien samlades år 2006 som en del av en stor datainsamling som utfördes av psykologiska fakulteten vid Åbo Akademi. Tre lika stora grupper av kvinnor skapades på basis av deras svar på en mått som mätte subjektiv upplevelse av sexuell ångest.

Vid frågor eller vid behov av mer information kan ni kontakta:

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