HHS Public Access

Author manuscript

Appetite. Author manuscript; available in PMC 2024 February 01.

Published in final edited form as:

Appetite. 2023 February 01; 181: 106410. doi:10.1016/j.appet.2022.106410.

Understanding Comorbidity Between Eating Disorder and Premenstrual Symptoms Using A Network Analysis Approach

Jody E. Finch[a], **Ziqian Xu**[b], **Jessica H. Baker**[b]

[a]Department of Psychology, Georgia State University, P.O. Box 5010, Atlanta, GA 30302-5010, USA

[b]Department of Psychiatry, University of North Carolina at Chapel Hill, CB #7160, 101 Manning Drive, Chapel Hill, NC 27599-7160, USA

Abstract

Eating disorder symptoms are associated with ovarian hormones and fluctuate predicably across the menstrual cycle. However, the specific symptoms that underlie these associations remain unclear. The current study aims to examine which specific eating disorder and premenstrual symptoms confer risk and maintain comorbidity using network analysis. Eating disorder and premenstrual symptoms were measured using the Eating Pathology Symptoms Inventory and the Daily Record of Severity of Problems, respectively, in a large sample of young adult females. Network analysis was used to explicate the structure of eating and premenstrual symptom networks separately and together. Eating disorder networks replicated previous literature and identified body dissatisfaction as a core feature, but was unique in identifying monitoring calories as an additional core feature. Central symptoms identified in the premenstrual symptom network were symptoms interference with daily life and activities and negative emotions brought on by hormone changes. Bridge symptoms between networks were identified as relating to eating behaviors, interference with daily activities, joint and muscle pain, and negative emotions brought on by hormone changes. This study suggests that the links between eating disorder and premenstrual symptoms extend past their individual effects on eating behavior and are indicative of a shared underlying mechanism.

Author Contributions

J.E. Finch: Conceptualization, Writing – Introduction, Discussion, Editing, and Final Draft Prepartion. **Z. Xu**: Conceptualization, Methodology, Analysis, Writing – Original Draft of Methodology and Results. **J.H. Baker**: Supervision, Conceptualization, Writing – Review and Editing.

Ethics Statement

The authors assert that research was performed in accordance with the Declaration of Helsinki and was approved by the University of North Carolina Biomedical Institutional Review Board (UNC IRB# 19–0557). Participants gave informed consent before the study was performed.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest to disclose.

Keywords

Network analysis; Eating disorders; Premenstrual symptoms

1. Introduction

Eating disorders (EDs) are serious mental health conditions with a lifetime prevalence of approximately 13.1% (Stice, Marti, & Rohde, 2013; Udo & Grilo, 2018). EDs are associated with high mortality (Chesney, Goodwin, & Fazel, 2014; Keshaviah et al., 2014), morbidity (Deter & Herzog, 1994; Herpertz-Dahlmann, 2009; Kessler et al., 2013), and relapse (Schaumberg et al., 2017). Although etiology is not fully understood, ED symptomatology has been shown to fluctuate in a predictable manner across the menstrual cycle and show specific associations with ovarian hormones (e.g., estrogens) (Baker, Girdler, & Bulik, 2012; Racine et al., 2012). Binge-type EDs (i.e., bulimia nervosa and binge-eating disorder) specifically, are also commonly comorbid with premenstrual dysphoric disorder (PMDD; Nobles et al., 2016) and show significant associations with premenstrual symptoms (PMS) (e.g., appetite changes, depressed mood, and fatigue; Hardin, Thornton, Munn-Chernoff, & Baker, 2019). Despite the significant associations observed between various aspects of menstrual cycle changes and ED symptoms, the specific symptoms underlying this association are unclear. To further understand the association between EDs and menstrual cycle changes, we examined the association between *specific* ED symptoms and *specific* PMS using network analysis.

There has been recent interest in the psychological literature in clarifying the association between EDs and comorbidities through a network analysis framework (Levinson, Vanzhula, Brosof, & Forbush, 2018). Network analysis is a statistical method arising from network theory, a theory which conceptualizes psychopathology as a network of interconnected nodes (symptoms) and edges (associations between symptoms) (Borsboom, 2017). Network analysis can elucidate which symptoms within a specific disorder most influence the rest of the network (central symptoms) and, thus, not only improve our understanding of etiology, but has potential for identifying effective treatment targets. When applied to comorbidity, network analysis directly examines how specific symptoms of one network of symptoms (e.g., PMS) may contribute to the symptoms of another network (e.g., EDs). This provides insight into the specific symptoms that may serve to maintain comorbidity and the pathway (bridge symptoms) that connects symptoms from one condition to another. For example, one study found that difficulty drinking beverages and eating in public served as bridge symptoms between EDs and social anxiety disorder (Levinson et al., 2018).

A significant yet understudied ED comorbidity is PMDD. PMDD is the experience of chronic and debilitating PMS, which leads to impairment in social and occupational activities (Lanza di Scalea & Pearlstein, 2019). Among those diagnosed with bulimia nervosa, prevalence of PMDD is 17.4% and among those diagnosed with binge-eating disorder, prevalence is 10.7% (Nobles et al., 2016), which is higher than the general population prevalence of PMDD which ranges from 3 to 8% (Halbreich, Borenstein, Pearlstein, & Kahn, 2003). The reverse is also true: women with PMDD are seven times

more likely to have comorbid bulimia nervosa and two times more likely to have comorbid binge-eating disorder (Nobles et al., 2016). Binge eating may be elevated in those with PMDD given the negative influence of PMDD on appetite for calorie-dense foods (Ko et al., 2015), which could propagate binge-eating behavior.

Indeed, we have previously shown using a stepwise regression model that PMS, defined from the 11 symptom domains of PMDD, are differentially associated with ED symptomology (Hardin et al., 2019). The majority of PMDD domains (e.g., depressed mood, anxiety, and fatigue) were associated with binge eating, body dissatisfaction, and restriction (Hardin et al., 2019), yet differences across symptoms emerged. Body dissatisfaction was most strongly associated with PMS appetite changes and depressed mood; binge eating with PMS appetite changes and concentration problems; restriction with PMS anxiety, feeling overwhelmed, and difficulties with sleep; and purging with PMS feeling overwhelmed and depressed mood (Hardin et al., 2019). However, given this previous study focused on cumulative PMDD and ED symptom domains, it is still unclear which specific symptom-type may be facilitating comorbidity.

Taken together, the aim of the current study was to extend our previous research by investigating which specific ED and PMS symptoms may confer the most risk and maintain ED and PMS symptom comorbidity using network analysis framework. Using the network analysis statistical model will provide insight into the pathway that connects PMS and ED symptoms. Secondarily, the network structure of PMS have not yet been examined. This paper will also provide important information on the interconnections between various symptoms of PMS, which comprise a PMDD diagnosis. As the focus of the paper was to investigate the network structure of PMS and the bridge network between PMS and ED symptoms, which have been limitedly examined in the literature, we did not make any specific a priori hypotheses.

2. Methods

2.1. Participants

Participants (n=666) were self-reported biological females at least 18 years of age from an American southeastern university who answered online questionnaires as part of a research study examining emotional health and the menstrual cycle in biological females. Participants completed informed consent prior to completing the online survey and received course credit for participating in the study. The Univeristy of North Carolina Biomedical Institutional Review Board (IRB #19–0557) approved the study.

2.2. Measures

2.2.1 Eating Disorder Symptoms—The Eating Pathology Symptoms Inventory (EPSI; Forbush et al., 2013) is a 5-point likert-scale self-report survey which was used to examine ED-related behaviors and cognitive patterns over the past 4 weeks. Forty items, which correspond to seven subscales, were included in the network analysis: (1) body dissatisfaction (i.e., dissatisfaction with one's body shape or weight), (2) binge eating (i.e., eating an objectively large amount of food and loss of control over eating), (3) cognitive

restraint (i.e., intentional avoidance of food, in particular calorie dense or "unhealthy" foods), (4) purging behaviors (i.e., compensatory behaviors such as vomiting or laxative use, to manage weight or shape), (5) excessive exercise (i.e., feeling compelled to exercise and/or exercising to the point of exhaustion), (6) restricting (i.e., eating unusually small amounts of food and/or skipping meals), (7) muscle building (i.e., desiring more muscular body shape and/or composition). Although we do not use subscale scores here, the EPSI subscales have demonstrated strong reliability and stability in community samples and in college samples specifically (Coniglio et al., 2018; Forbush, Wildes, & Hunt, 2014; Forbush et al., 2013). Specific items from the EPSI used in the network analysis were selected to facilitate comparison between the results of the current study and previous studies. If a different set of items were used, we would not be able to directly compare results as any differences observed could be due to item selection differences.

2.2.2. Premenstrual Symptoms—The Daily Record of Severity of Problems (DRSP; Endicott, Nee, & Harrison, 2006) is a 6-point likert-scale which was used to examine PMS (Table 1). The DRSP includes 24 items that query 11 specific domains of PMDD and an item measuring severity of symptoms as outlined in the DSM-IV (American Psychiatric Association, 2000): (1) depressed mood; (2) anxiety (i.e., feelings of tension or being on edge); (3) affective lability (i.e., feeling abruptly sad or having an increased sensitivity to rejection); (4) anger; (5) decreased interest in usual activities; (6) concentration problems; (7) fatigue; (8) appetite change (i.e., food cravings, overeating, or appetite change); (9) sleep problems (i.e., hypersomnia/insomnia); (10) feeling overwhelmed; and (11) physical symptoms (e.g., breast tenderness, headaches, bloating); and (12) how such symptoms interfere with daily activities. The DRSP has demonstrated strong reliability and stability (Endicott et al., 2006). It is intended for daily use; in the current cross-sectional study, the instructions were modified to ask participants to report the experience of PMS in the week prior to the onset of their menses (Hardin et al., 2019). Because this is the first study we are aware of examining PMS from a network analysis perspective, we included all DRSP items in the analysis.

2.3. Network Analyses

We completed a series of psychological network models to establish associations among 40 EPSI items and 24 DRSP items. R (Version 4.0.0; R Core Team, 2020) and R Studio (Version 1.3.959; RStudio Team, 2020) were used to construct these networks based on a publicly available network analysis R script (Levinson et al., 2018). We built three separate network models: (1) EPSI, (2) DRSP, and (3) bridges between the EPSI and DRSP. Similar to our previous study (Hardin et al., 2019), because the DRSP contains a specific item about overeating, which is also assessed by the EPSI, we ran a secondary bridge network (network 4) without the DRSP overeating item to investigate whether the network bridges changed with the removal of this overlapping item.

2.3.1. Network Graphs—We estimated networks with the EBIC*glasso* function in the *qgraph* package to minimize network sizes by eliminating spurious correlations (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). Specifically, the EBIC*glasso* function computes partial correlation networks with each correlation accounting for all other items

in the network. Within the networks, nodes represent EPSI or DRSP items and are shown as circles in network graphs. Network edges represent the partial correlations between items and are shown as lines connecting nodes in network graphs. Blue edges represent positive correlations whereas red edges represent negative correlations. Edge thickness indicates the strength of a correlation.

2.3.2. Network Centrality—The *qgraph* package in R (Epskamp et al., 2012) was used to calculate network centralities. Network centrality measures how likely activation of a certain symptom will be followed by activation of other symptoms that comprise the network (McNally, 2016). Similar to prior studies (Christian et al., 2020; Vanzhula, Calebs, Fewell, & Levinson, 2019) and following recommendations (McNally, 2016; Newman, 2010; Opsahl, Agneessens, & Skvoretz, 2010), we use strength centrality to estimate the importance of each network node. Strength is calculated as the sum of absolute weights of all edges connected to a target node. Using the package *bootnet* (Epskamp, Borsboom, & Fried, 2018), we also performed centrality difference tests to determine if the central nodes had significantly different strength centralities from other nodes. This analysis determines if the central nodes are significantly more central than others.

2.3.3. Network Stability—Stability of strength centrality was examined as a measure of network accuracy. Stability indicates the proportion of data that can be dropped to retain a correlation of 0.7 between the network with reduced data and the network with full data (Epskamp et al., 2018). A minimum stability of 0.25 is recommended to interpret networks (Epskamp & Fried, 2018).

2.3.4. Network Bridges and Comorbidity—For network 3 (and network 4), which examined bridges between ED symptoms and PMS, we analyzed bridges connecting these communities (i.e., EPSI and DRSP). Bridges are nodes from one community (i.e., EPSI) which are highly connected to nodes in another community (i.e., DRSP). Using the *networktools* package, we estimated bridge strength as an indicator of each bridge's statistical importance (Jones & Jones, 2018). Bridge strength is calculated as the sum of absolute edge weights from one node to all nodes not in the same community. Some previous studies of psychological comorbidity networks have used visual inspection on bridge strength plots to identify important bridges (Forrest, Sarfan, Ortiz, Brown, & Smith, 2019; Levinson et al., 2017; Vanzhula et al., 2019). However, more recently (Jones et al., 2019) it is recommended to use an 80% cutoff: retaining only the top 20% bridges with the strongest centrality. Here, potential bridges were first assessed through visual inspection of the network graphs, and then the statistical importance of the bridges between the EPSI and DRSP were determined by strength centrality.

3. Results

3.1. Participant Characteristics

Participants were self-reported biological females (N=666) with a mean age of 18.7 (SD = 1.1). The majority of participants were Caucasian (67%, N=446), followed by Asian (13%, N=85), African American (12%, N=77), Mixed Race (5%, N=30), Other (4%, N=27), and

Pacific Islander (<1%, N=1). The majority (91%, N=607) of the sample self-reported being non-Hispanic. In general, the demographics of the current sample match the university at the time of assessment. Confirming our previous study, a majority of the DRSP dimension scores were significantly correlated with the EPSI subscale scores (Table 2). Mean subscale scores for EPSI and DRSP subscales are reported in Table 3.

3.2. Network Analyses

EPSI and DRSP network abbreviations are provided in Table 1.

3.2.1. EPSI network—After removing participants missing all the EPSI items (i.e., participants who did not complete the survey), N=660 females remained for the EPSI network. Visually inspecting the EPSI network showed what appears to be 7 clusters: (1) 7 body dissatisfaction subscale items, (2) 6 restricting subscale items, (3) 8 binge eating subscale, (4) 5 excessive exercise subscale items, (5) 3 cognitive constraint subscale items, (6) 6 purging subscale items plus 1 muscle building item on thinking about steroids (node steroids), and (7) 3 muscle building items (Figure 1). The item *thinking about muscles being too small* did not fit into any of the visual clusters. As indicated by edge thickness, there were strong positive correlations among items within the same subscale.

We obtained central EPSI items by strength (Figure 2), which were similar to previous studies (Forbush et al., 2016; Christian et al., 2020). Items with highest strength centrality included *disliking how one's own body looked* (node body, S=2.18), *counting the calories of food being eaten* (node cal_count, S=1.33), *eating a large amount of food in a small amount of time* (node ate_large, S=1.03), and *pushing oneself extremely hard when exercising* (node ex_hard, S=0.98). These EPSI items were significantly more central than 95%,43%, 38%, and 39% of the other items with smaller strength centralities ($p<0.05$), respectively. Stability strength was 0.60, indicating that the EPSI network was interpretable.

3.2.2. DRSP network—After removing participants missing all the DRSP items (i.e., did not complete the questionnaire), n=663 females remained for the DRSP network. As shown in Figure 3, clusters in the DRSP network were not visually obvious, which could be due to the fact the DRSP does not have distinct subscales comprising multiple questions as does the EPSI, for example. Instead, the DRSP contains groupings of 1–3 items for each PMDD domain. However, as indicated by edge thickness, there were strong positive correlations between items of the same domain.

Central items included *the extent to which PMS interfere with hobbies and social activities* (node hobby, S=1.91), *feeling lethargic, tired, fatigued, or had a lack of energy* (node tired, S=1.83), *feeling hopeless* (node hopeless, S=1.43), and *the extent to which PMS interfere with productivity at work, school, or home* (node inefficiency, S=1.14) (Figure 4). These items were significantly more central than 61%, 60%, 58%, and 55% ($p<0.05$) of the other items with smaller strength centralities in the DRSP network, respectively. Stability strength was 0.60, indicating that the DRSP network was interpretable.

3.2.3. EPSI and DRSP—After removing participants completely missing for both the DRSP and the EPSI questionnaires, N=663 females remained for the network analysis.

Visually inspecting the network with both the DRSP and EPSI items showed that *snacking throughout the evening without realizing* may be a potential bridge connecting the two communities; however, both communities were visually relatively distinct (Figure 5). As shown in Figure 6, using a 20% cutoff (Jones et al., 2019), 12 items can be identified as potential bridges. EPSI items with high bridge strengths included *snacking throughout the evening without realizing* (node snack, S=0.192), *skipping two meals in a row* (node skip, S=0.081), and *making oneself vomit in order to lose weight* (node vomit, S=0.079). DRSP items with high bridge strengths included overeating (node overeat, S=0.249), *PMS interfering with hobbies or social activities* (node hobby, S=0.093), *having joint or muscle pains* (hobby jointmuscle, S=0.099), *feeling worthless or guilty* (node worthless, S=0.084), and *being sensitive to rejections or feelings easily getting hurt* (node sensitive, S=0.083). The bridge network has an acceptable strength stability of 0.52.

Removing the DRSP overeating item (Figure 7) resulted in bridge strength changes for both the DRSP and EPSI. We again identified 12 bridges with the 20% cutoff (Figure 8, Jones et al., 2019). Top items in the EPSI remained the same with minor changes in the bridge strength centrality statistics, while removing the DRSP overeat item changed DRSP items that are more likely to be bridges. Subsequently, DRSP bridge items included *having cravings for specific food* (node craving, S=0.108), which was not an item with high bridge strength before. Removing the overeat item did not change the network strength stability.

4. Discussion

The current study aimed to identify bridge symptoms between ED symptoms and PMS in young adult women. This study was also the first to investigate the network structure of the domains that comprise a diagnosis of PMDD. Overall, we replicated previous networks observed for ED symptomatology, identified specific symptoms to be central to PMS, and defined symptoms between EDs and PMS that may facilitate comorbidity.

Central symptoms identified for ED symptomatology corroborate previous studies (Christian et al., 2020; Forbush, Siew, & Vitevitch, 2016). Similar to previous studies, these findings support that aspects of body dissatisfaction, binge-eating, and excessive exercising behaviors represent a core features of eating pathology and should be prioritized in diagnostic criteria and as treatment targets (DuBois, Rodgers, Franko, Eddy, & Thomas, 2017; Forbush et al., 2016; Levinson et al., 2017). However, unlike previous studies we found monitoring calories to be a central symptom in the EPSI network. Central symptoms identified for PMS via the DRSP suggest that interference with daily life and activities and negative emotions brought on by hormone changes represent core features of PMS/PMDD. This aligns with current PMDD diagnostic criteria that prioritizes and requires the presence of mood symptoms and clinically significant distress or interference for a diagnosis to be made (American Psychiatric Association, 2013). As PMS have been implicated as partly due to postovulatory changes in ovarian hormones (Yonkers & Simoni, 2018), our findings also suggest that symptoms most central to PMS may display a greater sensitivity to changing hormone levels compared with other PMS. Such symptoms should be prioritized in theoretical models and these core features may serve as important treatment targets for PMS interventions in young adult female populations.

When assessing pathways between the ED and PMS networks, ED and PMS bridge symptoms identified were generally related to eating behaviors (vs cognitions/thoughts, for example), interference with daily activities, joint and muscle pain, and negative emotions brought on by hormone changes. In the full EPSI/DRSP network, the strongest bridge symptom across both the EPSI and DRSP was the DRSP overeating item. After the removal of the overeating item on the DRSP, DRSP food cravings became the strongest bridge symptom across the EPSI/DRSP network. Importantly, EPSI bridge symptoms skipping meals and compensatory vomiting were present in both EPSI/DRSP networks. Generally, these findings align with previous research indicating that PMS and PMDD are associated with binge-eating and bulimic type EDs (Nobles et al., 2016) and may be indicative of a shared underlying mechanism contributing to both EDs and PMS. Changes in eating behavior as a bridge symptom between ED and PMS networks is generally expected as both EDs and PMS share this characteristic. Despite this, interference with daily activies, joint and muscle pain, and negative emotions associated with hormone changes were also found to bridge ED and PMS networks, which suggests that the links between EDs and PMS extend past their similar individual effects on eating behavior.

Both before and after the removal of the DRSP overeating item, DRSP items feelings of worthlessness, sensitivity to rejection, and joint and muscle pain were top bridge symptoms in both EPSI/DRSP networks. This demonstrates that PMS related to negative emotions and physical bodily discomfort brought on by hormone changes may serve as additional pathways between EDs and PMS, in addition to binge-eating, and facilitate comorbidity. Importantly, identification of bridge symptoms between ED and PMS networks elucidates symptoms most critical to target in the treatment of comorbid EDs and PMS.

There are limitations to the current study worth noting. First, the DRSP was used retrospectively and we did not define current menstrual cycle phase for each participant. Thus, DRSP symptoms could have been influenced by memory. Secondly, due to the window of DRSP symptom inquiry, we are unable to ascertain if symptoms were only onset premenstrually or were present prior to the premenstrual window assessed but exacerbated during this time. However, we would argue that both new onset or exacerbation of symptoms are important to capture as each would represent change in symptoms based on menstrual cycle phase. Additionally, the sample was comprised of college-aged women which may limit generalizability to the larger population; however, this population is of particular interest because of elevated prevalence to both EDs and PMS symptomology (Harrer et al., 2020; Steiner, Macdougall, & Brown, 2003). The current study did not exclude women on a hormone-based birth control. It is possible that women on birth control would be less likely to report cycle-driven hormone fluctuations and less PMS. However, requiring “regular” menstrual cycles may decrease the generalizability of the sample as estimates of irregular menstruation vary from 5–36% (Nohara, Momoeda, Kubota, & Nakabayashi, 2011; Sakai & Ohashi, 2013; Toffol, Koponen, Luoto, & Partonen, 2014; Zhou et al., 2010). Furthermore, the presence of regular cycles does not indicate the absence of PMS (Park, Shin, Jeon, Cho, & Kim, 2021). Rather than requiring a regular cycle or participants to be in a certain phase, we instructed participants to consider the phase of the cycle we are interested in. As we direct participants to report on the cycle phase that we are interested in for the current study, the regularity of their menses and the determination of participants cycle phase through

medical means is not necessary to investigate their experience of PMS. In addition, previous literature has shown that being on birth control does not impact findings on the association between PMS and ED symptoms (Hardin et al., 2019) and is associated with elevated ED symptomology (Bird & Oinonen, 2011) which suggests a possible sensitivity to ovarian hormones is associated with ED symptoms. Finally, due to the cross-sectional nature of the current study, we are unable to make conclusions about causality. Future research should therefore investigate comorbidity between PMS and EDs by addressing these limitations via longitudinal studies in a more diverse sample to determine directionality of symptoms. Additionally, it will be important for future research to investigate sensitivity to changes in ovarian hormones as a possible shared underlying etiological factor to both EDs and PMS. For example, examining how fluctuations in ovarian hormones affect central ED symptoms at different phases of the menstrual cycle, in particular during the pre-menstrual phase when PMS onset. Hormonal change as a plausible mechanism underlying the associations between EDs and PMS, however, is speculative and future research should investigate such mechanisms.

Network analysis is a powerful statistical tool to investigate core features of psychopathology and can further our understanding of the transmechanistic etiological factors of PMS and EDs. The current study replicated previous findings of body dissatisfaction, binge-eating, and excessive exercise as a core symptoms of EDs while presenting new evidence that monitoring calories may be similarly core to EDs. Likewise, negative emotions brought on by hormone changes and interference with daily activities were core symptoms of PMS, which corroborates prioritization of mood and clinically significant distress PMDD diagnostic criteria. Bridge symptom findings suggest that high levels of DRSP bridge symptoms in an individual may elevate risk for ED symptomology (or vice versa given temporal ordering cannot be determined) and that symptoms of body dissatisfaction, negative emotions, and physical bodily discomfort brought on by hormone changes may be illness pathways, along with overeating, between EDs and PMS. Given PMS is caused in part by changes in ovarian hormones (Yonkers & Simoni, 2018) and there are associations between changes in ED symptomology and phases of the menstrual cycle (Baker, Girdler, & Bulik, 2012), sensitivity to fluctuations in ovarian hormones may represent a shared etiological factor between EDs and PMS. Findings advocate for treatment targets with a focus on body dissatisfaction, negative emotions and physical bodily discomfort brought on by hormone changes, and changes in eating behavior in comorbid EDs and PMS. Furthermore, given evidence for illness pathways between EDs and PMS, treatments that show benefit for PMDD may also benefit those with an ED.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding Sources

Time to analyze data and draft the manuscript was partially funded by the National Institute of Health R21MH121726 (PI: Baker).

Data Code and Avaliability Statement

Data will be provided upon reasonable request.

References

American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders (5th ed.). Arlington, VA.

Association, A. P. (2000). Diagnostic and statistical manual of mental disorders (4th ed., Text Revision ed.). Washington, DC: American Psychiatric Press.

Baker JH, Girdler SS, & Bulik CM (2012). The role of reproductive hormones in the development and maintenance of eating disorders. Expert Review of Obstetrics & Gynecology, 7, 573–583. [PubMed: 23585773]

Bird JL, & Oinonen KA (2011). Elevated eating disorder symptoms in women with a history of oral contraceptive side effects. Archives of Women's Mental Health, 14, 345–353.

Borsboom D (2017). A network theory of mental disorders. World Psychiatry, 16, 5–13. [PubMed: 28127906]

Chesney E, Goodwin GM, & Fazel S (2014). Risks of all-cause and suicide mortality in mental disorders: a meta-review. World Psychiatry, 13, 153–160. [PubMed: 24890068]

Christian C, Williams BM, Hunt RA, Wong VZ, Ernst SE, Spoor SP, Vanzhula IA, Tregarthen JP, Forbush KT, & Levinson CA (2020). A network investigation of core symptoms and pathways across duration of illness using a comprehensive cognitive-behavioral model of eating-disorder symptoms. Psychological Medicine, 1–10.

Coniglio KA, Becker KR, Tabri N, Keshishian AC, Miller JD, Eddy KT, & Thomas JJ (2018). Factorial integrity and validation of the Eating Pathology Symptoms Inventory (EPSI). Eating Behaviors, 31, 1–7. [PubMed: 30025234]

Deter HC, & Herzog W (1994). Anorexia nervosa in a long-term perspective: Results of the Heidelberg-Mannheim study. Psychosomatic Medicine, 56, 20–27. [PubMed: 8197311]

DuBois RH, Rodgers RF, Franko DL, Eddy KT, & Thomas JJ (2017). A network analysis investigation of the cognitive-behavioral theory of eating disorders. Behaviour Research and Therapy, 97, 213–221. [PubMed: 28826067]

Endicott J, Nee J, & Harrison W (2006). Daily Record of Severity of Problems (DRSP): reliability and validity. Archives of Women's Mental Health, 9, 41–49.

Epskamp S, Borsboom D, & Fried EI (2018). Estimating psychological networks and their accuracy: A tutorial paper. Behavior Research Methods, 50, 195–212. [PubMed: 28342071]

Epskamp S, Cramer AO, Waldorp LJ, Schmittmann VD, & Borsboom D (2012). qgraph: Network visualizations of relationships in psychometric data. Journal of Statistical Software, 48, 1–18.

Epskamp S, & Fried EI (2018). A tutorial on regularized partial correlation networks. Psychological Methods, 23, 617–634. [PubMed: 29595293]

Forbush KT, Siew CSQ, & Vitevitch MS (2016). Application of network analysis to identify interactive systems of eating disorder psychopathology. Psychological Medicine, 46, 2667. [PubMed: 27387196]

Forbush KT, Wildes JE, & Hunt TK (2014). Gender norms, psychometric properties, and validity for the Eating Pathology Symptoms Inventory. International Journal of Eating Disorders, 47, 85–91. [PubMed: 23996154]

Forbush KT, Wildes JE, Pollack LO, Dunbar D, Luo J, Patterson K, Petruzzi L, Pollpeter M, Miller H, Stone A, Bright A, & Watson D (2013). Development and validation of the Eating Pathology Symptoms Inventory (EPSI). Psychological Assessment, 25, 859. [PubMed: 23815116]

Forrest LN, Sarfan LD, Ortiz SN, Brown TA, & Smith AR (2019). Bridging eating disorder symptoms and trait anxiety in patients with eating disorders: A network approach. International Journal of Eating Disorders, 52, 701–711. [PubMed: 30900758]

Halbreich U, Borenstein J, Pearlstein T, & Kahn LS (2003). The prevalence, impairment, impact, and burden of premenstraul dysphoric disorder (PMS/PMDD). Psychoneuroendocrinology, 28, 1–23.

Hardin SL, Thornton LM, Munn-Chernoff MA, & Baker JH (2019). Premenstrual symptoms as a marker of ovarian hormone sensitivity in eating disorders. International Journal of Eating Disorders, 53, 296–301. [PubMed: 31846101]

Harrer M, Adam SH, Messner E-M, Baumeister H, Cuijpers P, Bruffaerts R, Auerbach RP, Kessler RC, Jacobi C, Taylor CB, & Ebert DD (2020). Prevention of eating disorders at universities: A systematic review and meta-analysis. International Journal of Eating Disorders, 53, 813–833. [PubMed: 31943298]

Herpertz-Dahlmann B (2009). Adolescent Eating Disorders: Definitions, Symptomatology, Epidemiology and Comorbidity. Child and Adolescent Psychiatric Clinics of North America, 18, 31–47. [PubMed: 19014856]

Jones PJ, & Jones MP (2018). Package 'network tools'. In (Vol. 2018).

Jones PJ, Ma R, & McNally RJ (2019). Bridge centrality: A network approach to understanding comorbidity. Multivariate Behavioral Research, 56, 353–367. [PubMed: 31179765]

Keshaviah A, Edkins K, Hastings ER, Krishna M, Franko DL, Herzog DB, Thomas JJ, Murray HB, & Eddy KT (2014). Re-examining premature mortality in anorexia nervosa: a meta-analysis redux. Comprehensive Psychiatry, 55, 1773–1783. [PubMed: 25214371]

Kessler RC, Berglund PA, Chiu WT, Deitz AC, Hudson JI, Shahly V, Aguilar-Gaxiola S, Alonso J, Angermeyer MC, Benjet C, Bruffaerts R, de Girolamo G, de Graaf R, Maria Haro J, Kovess-Masfety V, O'Neill S, Posada-Villa J, Sasu C, Scott K, …, & Xavier M (2013). The prevalence and correlates of binge eating disorder in the World Health Organization World Mental Health Surveys. Biological Psychiatry, 73, 904–914. [PubMed: 23290497]

Ko CH, Yen CF, Long CY, Kuo YT, Chen CS, & Yen JY (2015). The late-luteal leptin level, caloric intake and eating behaviors among women with premenstrual dysphoric disorder. Psychoneuroendocrinology, 56, 52–61. [PubMed: 25800149]

Lanza di Scalea T, & Pearlstein T (2019). Premenstrual Dysphoric Disorder. The Medical Clinics of North America, 103, 613–628. [PubMed: 31078196]

Levinson CA, Brosof LC, Vanzhula I, Christian C, Jones P, Rodebaugh TL, Langer JK, White EK, Warren C, Weeks JW, Menatti A, Lim MH, & Fernandez KC (2018). Social anxiety and eating disorder comorbidity and underlying vulnerabilities: Using network analysis to conceptualize comorbidity. International Journal of Eating Disorders, 51, 693–709. [PubMed: 30102777]

Levinson CA, Vanzhula IA, Brosof LC, & Forbush K (2018). Network Analysis as an Alternative Approach to Conceptualizing Eating Disorders: Implications for Research and Treatment. Current Psychiatry Reports, 20, 67. [PubMed: 30079431]

Levinson CA, Zerwas S, Calebs B, Forbush K, Kordy H, Watson H, Hofmeier S, Levine M, Crosby RD, Peat C, Runfola CD, Zimmer B, Moesner M, Marcus MD, & Bulik CM (2017). The core symptoms of bulimia nervosa, anxiety, and depression: A network analysis. Journal of Abnormal Psychology, 126, 340. [PubMed: 28277735]

McNally RJ (2016). Can network analysis transform psychopathology? . Behaviour Research and Therapy, 86, 95–104. [PubMed: 27424882]

Newman M (2010). Networks: An introduction. Oxford, England: Oxford University Press.

Nobles CJ, Thomas JJ, Valentine SE, Gerber MW, Vaewsorn AS, & Marques L (2016). Association of premenstrual syndrome and premenstrual dysphoric disorder with bulimia nervosa and binge-eating disorder in a nationally representative epidemiological sample. International Journal of Eating Disorders, 49, 641–650. [PubMed: 27206163]

Nohara M, Momoeda M, Kubota T, & Nakabayashi M (2011). Menstrual cycle and menstrual pain problems and related risk factors among Japanese female workers. Industrial Health, 49, 228–234. [PubMed: 21173526]

Opsahl T, Agneessens F, & Skvoretz J (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. Social Networks, 32, 245–251.

Park Y-J, Shin H, Jeon S, Cho I, & Kim Y-J (2021). Menstrual Cycle Patterns and the Prevalence of Premenstrual Syndrome and Polycystic Ovary Syndrome in Korean Young Adult Women. Healthcare, 9, 56. [PubMed: 33430265]

Racine SE, Culbert KM, Keel PK, Sisk CL, Burt SA, & Klump KL (2012). Differential associations between ovarian hormones and disordered eating symptoms across the menstrual cycle in women. The International Journal of Eating Disorders, 45(3) 333–334. [PubMed: 21656540]

Sakai H, & Ohashi K (2013). Association of menstrual phase with smoking behavior, mood and menstrual phase-associated symptoms among young Japanese women smokers. BMC Womens Health, 13, 10. [PubMed: 23452831]

Schaumberg K, Welch E, Breithaupt L, Hübel C, Baker JH, Munn-Chernoff MA, Yilmaz Z, Ehrlich S, Mustelin L, Ghaderi A, Hardaway AJ, Bulik-Sullivan EC, Hedman AM, Jangmo A, Nilsson IAK, Wiklund C, Yao S, Seidel M, & Bulik CM (2017). The science behind the academy for eating disorders' nine truths about eating disorders. European Eating Disorders Review, 25, 432–450. [PubMed: 28967161]

Steiner M, Macdougall M, & Brown E (2003). The premenstrual symptoms screening tool (PSST) for clinicians. Archives of Women's Mental Health, 6, 203–209.

Stice E, Marti CN, & Rohde P (2013). Prevalence, incidence, impairment, and course of the proposed DSM-5 eating disorder diagnoses in an 8-year prospective community study of young women. Journal of Abnormal Psychology, 122, 445–457. [PubMed: 23148784]

Team, R. (2020). RStudio: Integrated development environment for R. In (1.3.959 ed.). Boston, MA: RStudio, PBC.

Team, R. C. (2020). R: A language and environment for statistical computing. In (4.0.0 ed.). Vienna, Austria: R Foundation for Statistical Computing.

Toffol E, Koponen P, Luoto R, & Partonen T (2014). Pubertal timing, menstrual irregularity, and mental health: results of a population-based study. Archives of Women's Mental Health, 17, 127–135.

Udo T, & Grilo CM (2018). Prevalence and correlates of DSM-5 defined eating disorders in a nationally representative sample of U.S. adults. Biological Psychiatry, 84, 345–354. [PubMed: 29859631]

Vanzhula IA, Calebs B, Fewell L, & Levinson CA (2019). Illness pathways between eating disorder and post-traumatic stress disorder symptoms: Understanding comorbidity with network analysis. European Eating Disorders Review, 27, 147–160. [PubMed: 30084217]

Yonkers KA, & Simoni MK (2018). Premenstrual disorders. American Journal of Obstetrics and Gynecology, 218, 68–74. [PubMed: 28571724]

Zhou M, Wege N, Gu H, Shang L, Li J, & Siegrist J (2010). Work and family stress is associated with menstrual disorders but not with fibrocystic changes: cross-sectional findings in Chinese working women. Journal of Occupational Health, 52, 361–366. [PubMed: 20944439]

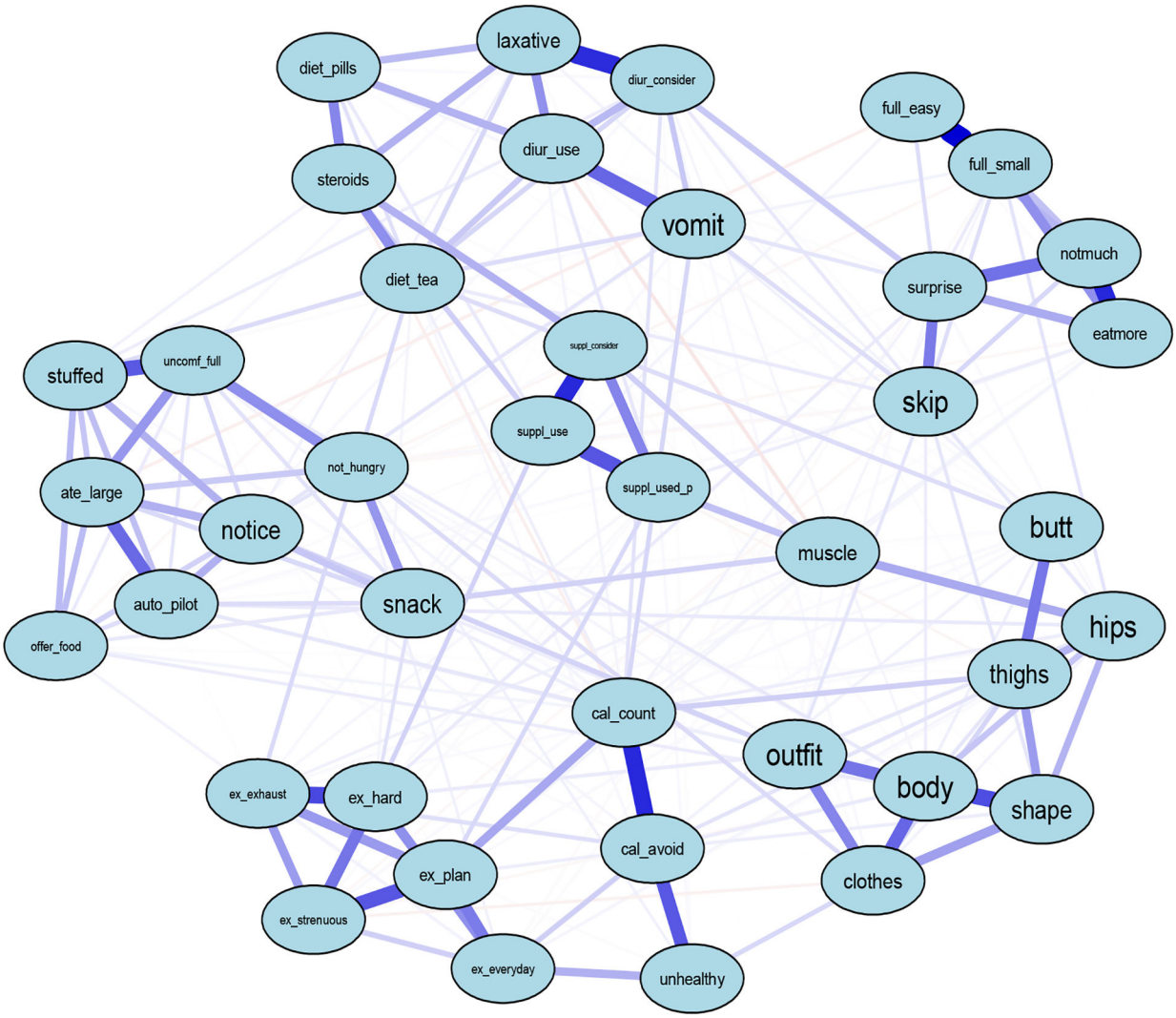

Figure 1.

EPSI Eating Disorder Symptom Network

Note. Abbreviations of nodes available in Table 1.

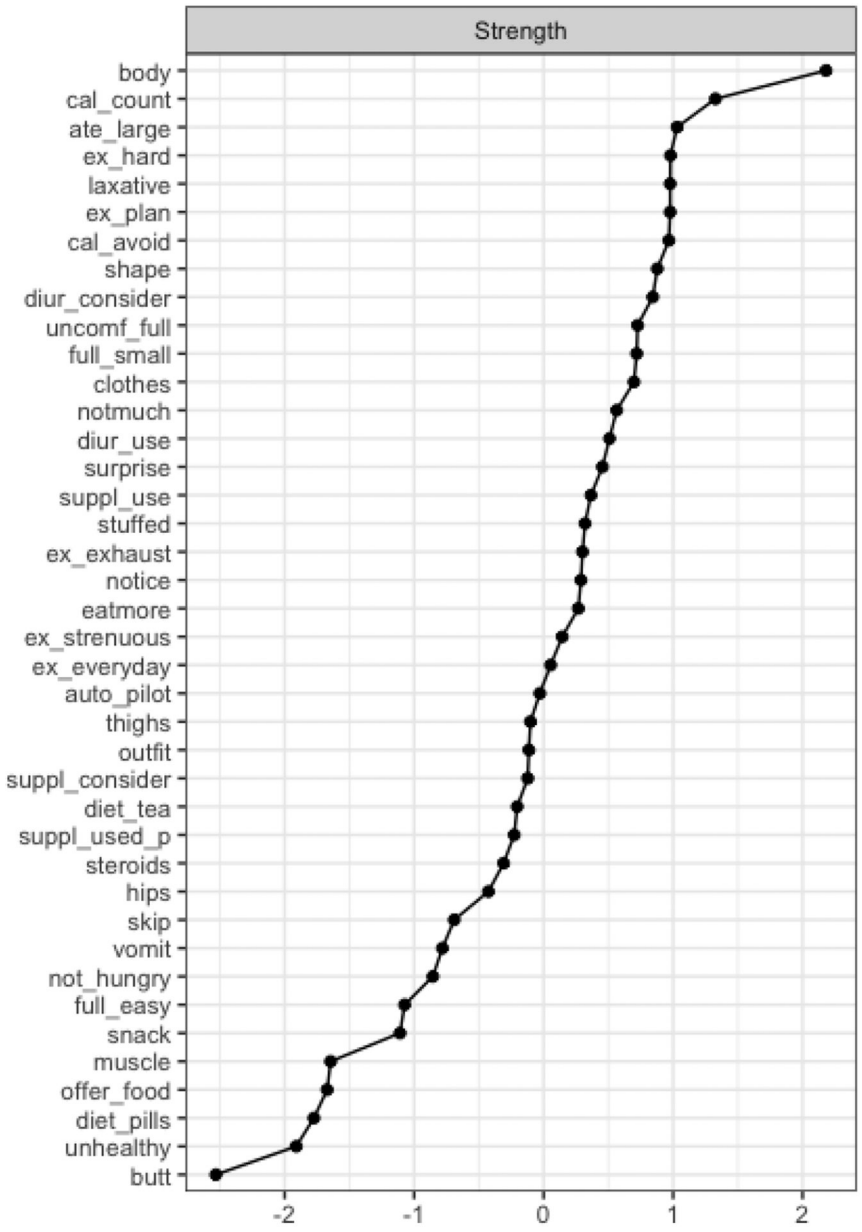

Figure 2.

Strength Centrality of EPSI Network Items

Note. Items are sorted in a decreasing order by the respective centrality measure. Abbreviations used in the centrality graphs are available in Table 1.

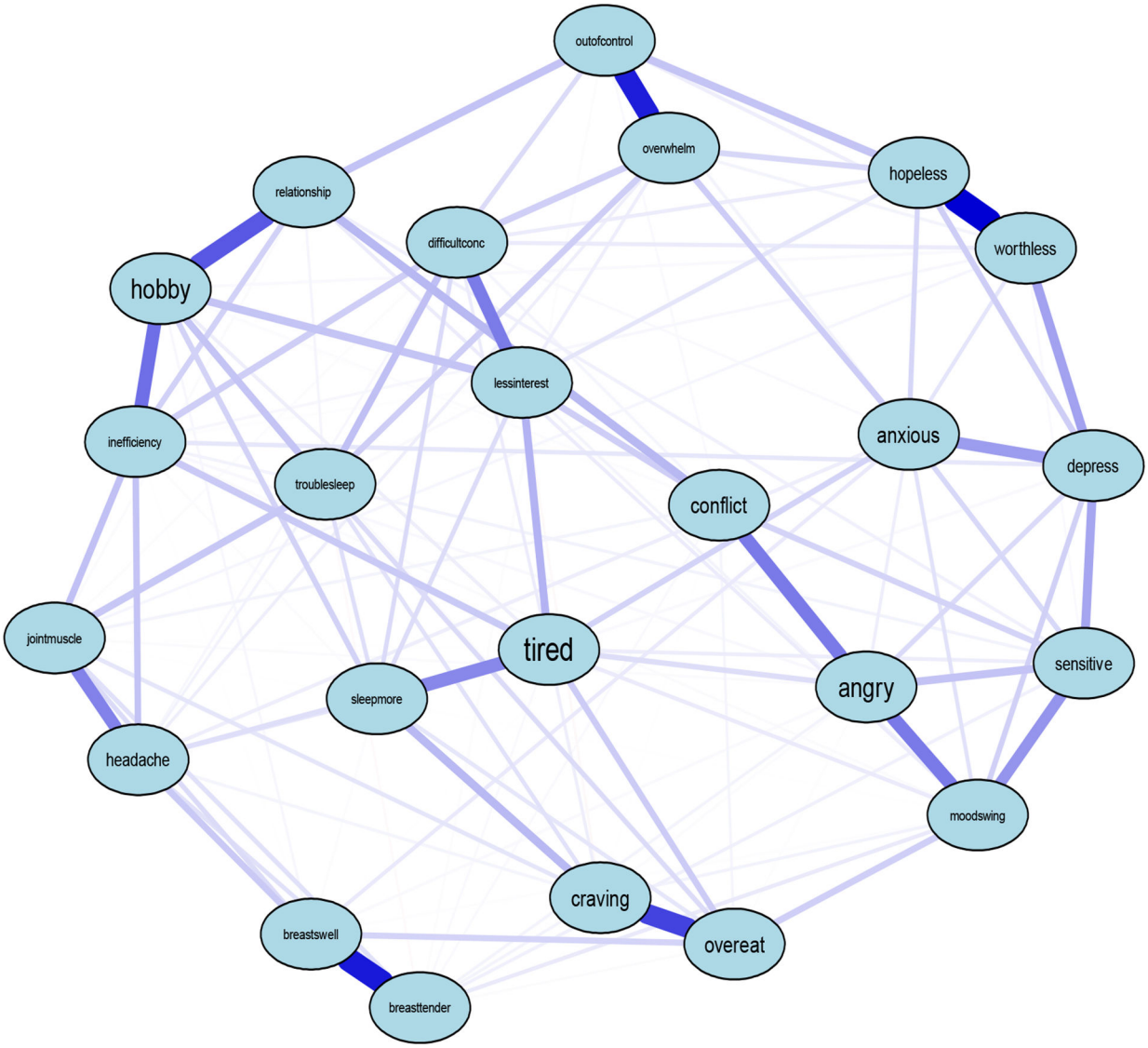

Figure 3.
DRSP PMS Symptom Network
Note. Abbreviations of nodes can be found in Table 1

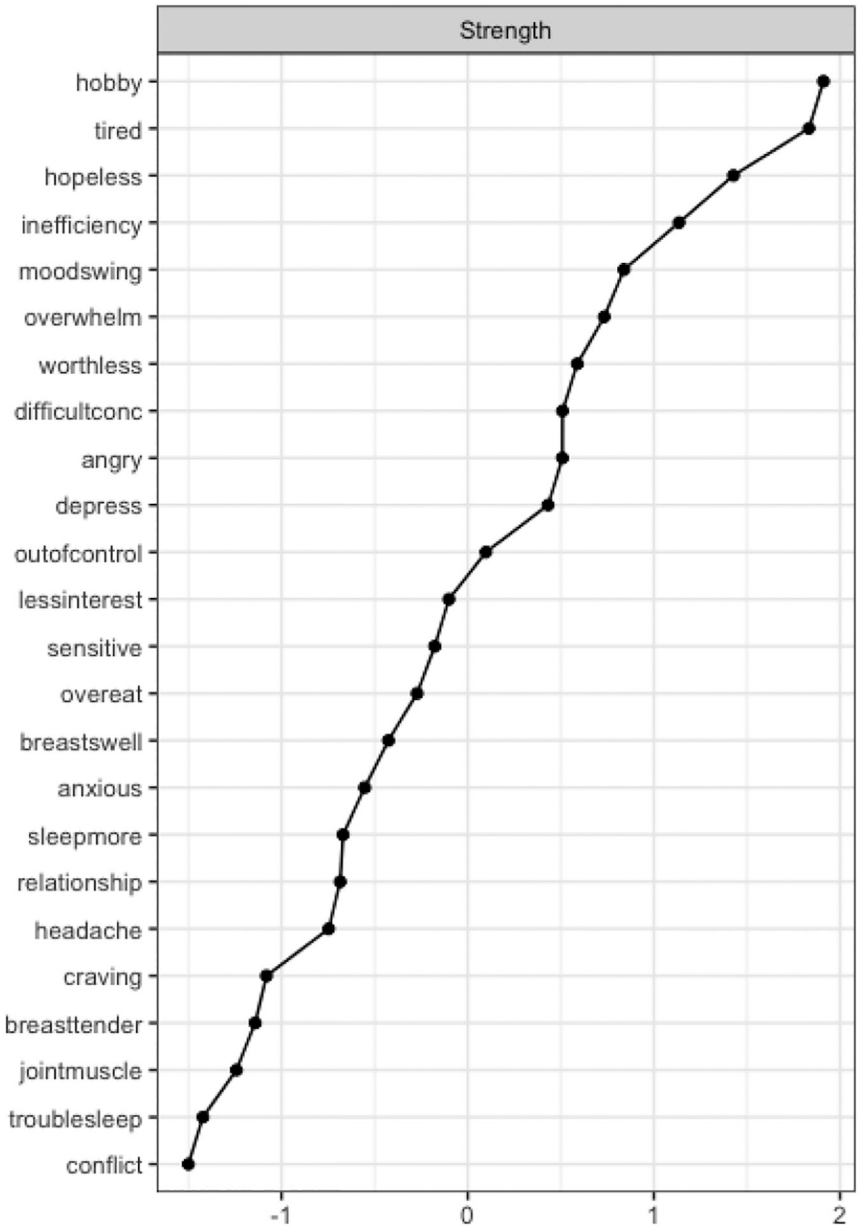

Figure 4.

Strength Centrality of the DRSP Network

Note. Nodes are sorted in a decreasing order by the respective centrality measure. Abbreviations used in the centrality graphs are available in Table 1.

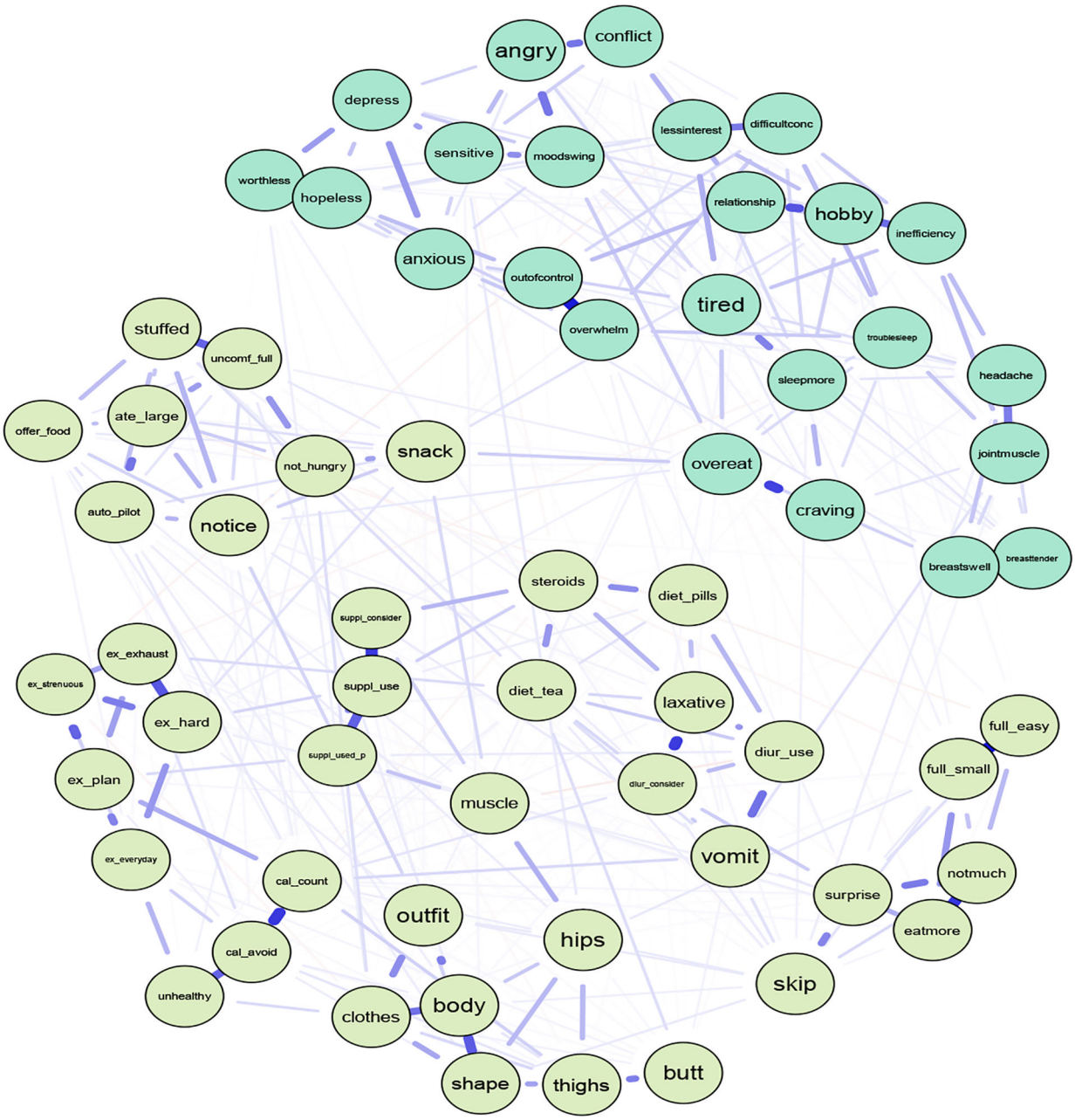

Figure 5.

Network with EPSI Items and DRSP Items with DRSP Overeat Item

Note. Abbreviations of nodes available in Table 1. Light blue nodes represent DRSP items and light green nodes represent EPSI items.

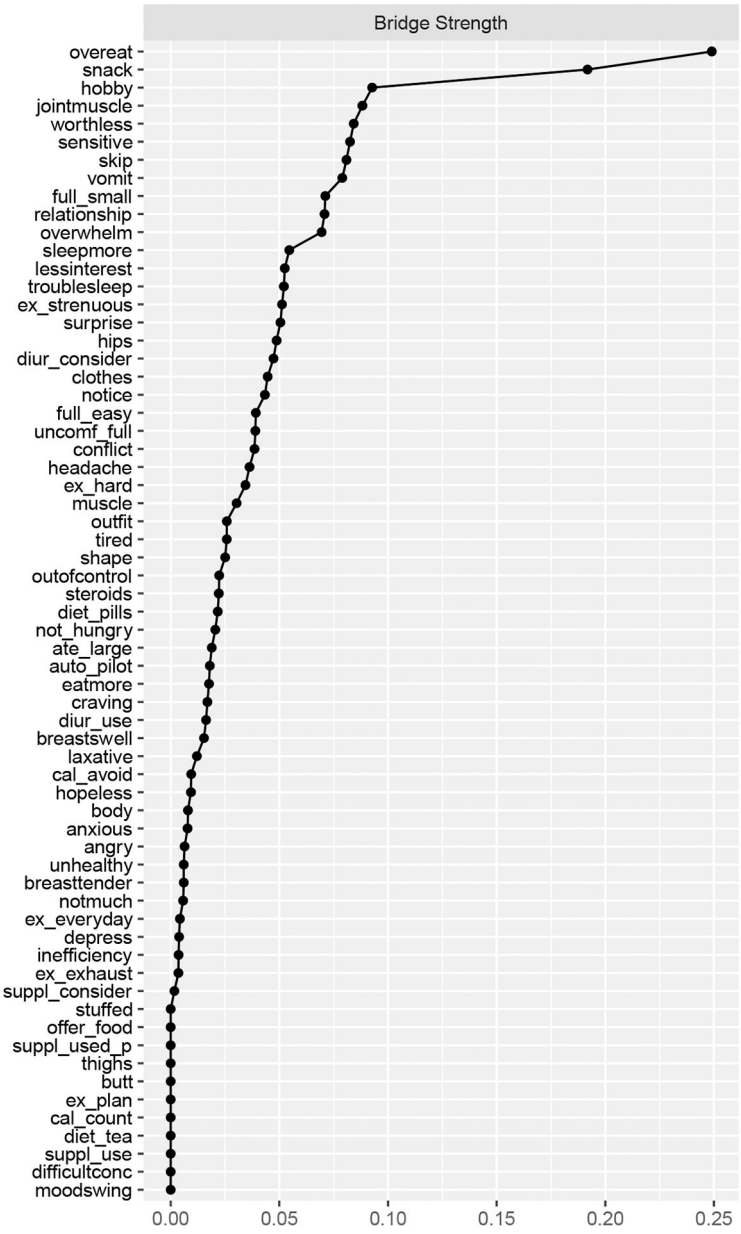

Figure 6.

Bridge Strength Centrality EPSI and DRSP Items

Note. Nodes are sorted in a decreasing order by the respective centrality measure. Abbreviations used in the centrality graphs are available in Table 1.

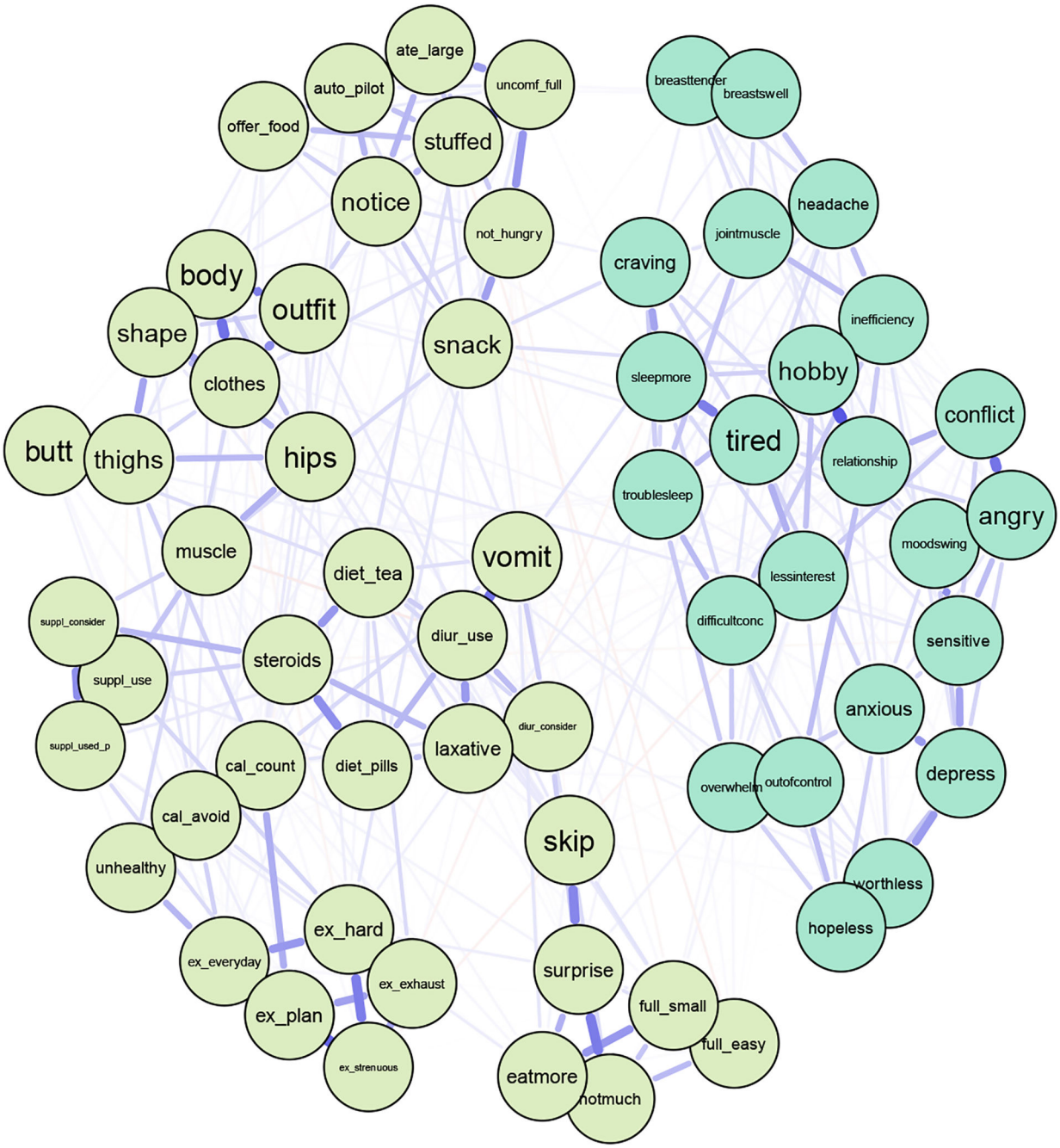

Figure 7.

Network with EPSI Items and DRSP Items without DRSP Overeat Item

Note. Abbreviations of nodes can be found in Table 1. Light blue nodes represent DRSP items and light green nodes represent EPSI items.

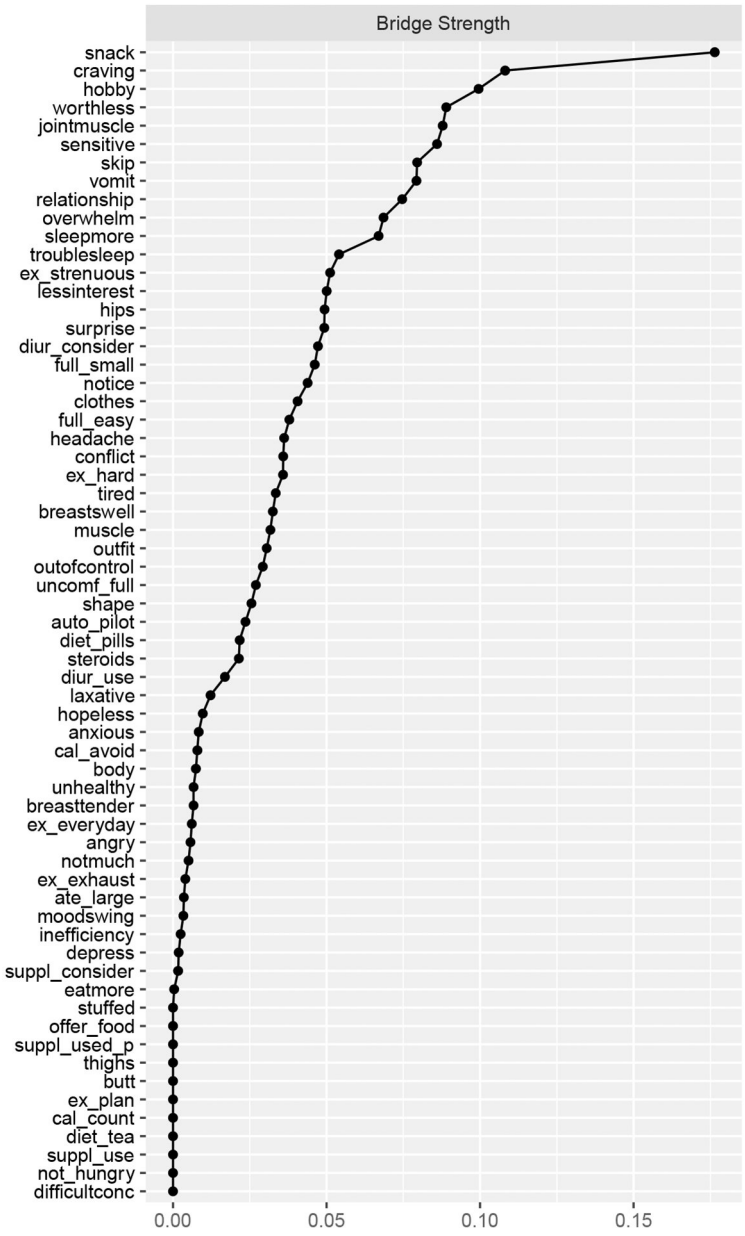

Figure 8.

Bridge Strength Centrality of DRSP and EPSI Items After Removing the DRSP Overeat

Note. Nodes are sorted in a decreasing order by the respective centrality measure. Abbreviations used in the centrality graphs are available in Table 1.

Table 1

Abbreviations Used for EPSI and DRSP Items in Network Models

EPSI	
Abbreviation	**Item**
Clothes	1. I did not like how clothes fit the shape of my body
Unhealthy	2. I tried to exclude “unhealthy” foods from my diet
Not_hungry	3. I ate when I was not hungry
Notmuch	4. People told me that I do not eat very much
Ex_everyday	5. I felt that I needed to exercise nearly every day
Surprise	6. People would be surprised if they knew how little I ate
Suppl_use	7. I used muscle building supplements
Ex_hard	8. I pushed myself extremely hard when I exercised
Snack	9. I snacked throughout the evening without realizing it
Full_easy	10. I got full more easily than most people
Diur_consider	11. I considered taking diuretics to lose weight
Outfit	12. I tried on different outfits, because I did not like how I looked
Laxative	13. I thought laxatives are a good way to lose weight
Steroids	15. I thought about taking steroids as a way to get more muscular
Diet_tea	16. I used diet teas or cleansing teas to lose weight
Diet_pills	17. I used diet pills
Body	18. I did not like how my body looked
Uncomf_full	19. I ate until I was uncomfortably full
Cal_count	21. I counted the calories of foods I ate
Ex_plan	22. I planned my days around exercising
Butt	23. I thought my butt was too big
Thighs	24. I did not like the size of my thighs
Shape	25. I wished the shape of my body was different
Vomit	27. I made myself vomit in order to lose weight
Notice	28. I did not notice how much I ate until after I had finished eating
Suppl_consider	29. I considered taking a muscle building supplement
Ex_strenuous	31. I engaged in strenuous exercise at least five days per week
Muscle	32. I thought my muscles were too small
Full_small	33. I got full after eating what most people would consider a small amount of food
Hips	34. I was not satisfied with the size of my hips
Suppl_used_p	35. I used protein supplements
Eatmore	36. People encouraged me to eat more
Offer_food	37. If someone offered me food, I felt that I could not resist eating it
Stuffed	39. I stuffed myself with food to the point of feeling sick
Cal_avoid	40. I tried to avoid foods with high calorie content
Ex_exhaust	41. I exercised to the point of exhaustion

Diur_use	42. I used diuretics in order to lose weight
Skip	43. I skipped two meals in a row
Auto_pilot	44. I ate as if I was on auto-pilot
Ate_large	45. I ate a very large amount of food in a short period of time (e.g., within 2 hours)
DRSP	
Abbreviation	**Item**
Depress	1a. Felt depressed, sad, “down,” or “blue”
Hopeless	1b. Felt hopeless
Worthless	1c. Felt worthless, or guilty
anxious	2. Felt anxious, tense, “keyed up” or “on edge”
Moodswing	3a. Had mood swings (e.g., suddenly felt sad or tearful)
Sensitive	3b. Was more sensitive to rejection or my feelings were easily hurt
Angry	4a. Felt angry, irritable
Conflict	4b. Had conflicts or problems with people
Lessinterest	5. Had less interest in usual activities (e.g., work, school, friends, hobbies)
Difficultconc	6. Had difficulty concentrating
Tired	7. Felt lethargic, tired, fatigued, or had a lack of energy
Overeat	8a. Had increased appetite or overate
Craving	8b. Had cravings for specific foods
Sleepmore	9a. Slept more, took naps, found it hard to get up when intended
Troublesleep	9b. Had trouble getting to sleep or staying asleep
Overwhelm	10a. Felt overwhelmed or that I could not cope
Outofcontrol	10b. Felt out of control
Breasttender	11a. Had breast tenderness
Breastswell	11b. Had breast swelling, felt “bloated”, or had weight gain
Headache	11c. Had headache
Jointmuscle	11d. Had joint or muscle pain
Inefficiency	At work, at school, at home, or in daily routine, at least one of the problems noted above caused reduction of productivity or inefficiency
Hobby	At least one of the problems noted above interfered with hobbies or social activities (e.g., avoid or do less)
Relationship	At least one of the problems noted above interfered with relationships with others

Table 2

Pearson Correlation Analysis Between EPSI Subscales and DRSP Subscales

	BD	BE	Cognitive Constraint	Purging	Restrict	Exercise	Muscle
Depression	**0.3**	**0.3**	**0.2**	**0.3**	**0.3**	**0.1**	**0.2**
Anxiety	**0.3**	**0.2**	**0.2**	**0.2**	**0.3**	**0.1**	**0.1**
Affective Lability	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**
Interest	**0.2**	**0.2**	**0.1**	**0.2**	**0.3**	0.0	**0.1**
Concentrate	**0.2**	**0.2**	**0.1**	**0.2**	**0.2**	**0.1**	**0.1**
Appetite	**0.3**	**0.4**	**0.2**	**0.2**	**0.1**	**0.2**	**0.1**
Anger	**0.2**	**0.2**	**0.1**	**0.2**	**0.3**	**0.1**	**0.1**
Insomnia	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.1**	**0.1**
Overwhelm	**0.2**	**0.3**	**0.2**	**0.3**	**0.3**	**0.2**	**0.2**
Physical	**0.3**	**0.2**	**0.2**	**0.3**	**0.3**	**0.2**	**0.1**
Inefficiency	**0.3**	**0.3**	**0.1**	**0.2**	**0.3**	**0.1**	**0.1**
Relationship	**0.2**	**0.3**	**0.2**	**0.3**	**0.3**	**0.1**	**0.2**
Hobby	**0.3**	**0.3**	**0.2**	**0.3**	**0.3**	**0.2**	**0.2**

Bolded: $p < .05$

Table 3

EPSI and DRSP Mean Subscale Scores

EPSI (N = 658)		**Mean**	**SD**
	Body Dissatisfaciton	12.43	6.89
	Binge Eating	5.17	3.44
	Cognitive Restraint	3.36	2.04
	Purging	1.1	2.67
	Restricting	4.95	4.94
	Excessive Exercise	4.68	4.51
	Muscle Building	1.74	2.72
DRSP (N = 663)			
	Affective Liability	6.82	2.58
	Irritability/ Anger or Interpersonal Conflicts	5.79	2.4
	Depressed Mood/Hopelessness	7.73	3.71
	Anxiety/ Tension	3.11	1.44
	Decreased Interest in Usual Activities	2.53	1.35
	Difficulty Concentrating	2.37	1.36
	Lethargy/ Fatigue	3.25	1.48
	Appetite Changes	5.97	2.77
	Hypersomnia/Insomnia	5.22	2.57
	Overwhelmed/ Out of Control	4.24	2.61
	Physical Symptoms	7.9	3.66