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## ARTIGOS

## Interação e centralidade dos sintomas internalizantes do HiTOP: comparação de redes entre mulheres e homens

*Interplay and centrality of HiTOP internalizing symptoms: network comparison between females and males*

*Interacción y centralidad de síntomas internalizantes de HiTOP: comparación de redes entre mujeres y hombres*

**Gisele Magarotto Machado<sup>1</sup>**

[orcid.org/0000-0003-1983-6636](http://orcid.org/0000-0003-1983-6636)  
[gimagarotto@hotmail.com](mailto:gimagarotto@hotmail.com)

**Ariela Raissa Lima-Costa<sup>2</sup>**

[orcid.org/0000-0002-5942-6466](http://orcid.org/0000-0002-5942-6466)  
[arielalima10@gmail.com](mailto:arielalima10@gmail.com)

**Marcela Mansur-Alves<sup>3</sup>**

[orcid.org/0000-0002-3961-3475](http://orcid.org/0000-0002-3961-3475)  
[marmansura@gmail.com](mailto:marmansura@gmail.com)

**Bruno Bonfá-Araujo<sup>4</sup>**

[orcid.org/0000-0003-0702-9992](http://orcid.org/0000-0003-0702-9992)  
[brunobonffa@outlook.com](mailto:brunobonffa@outlook.com)

**Lucas de Francisco Carvalho<sup>2</sup>**

[orcid.org/0000-0002-3274-9724](http://orcid.org/0000-0002-3274-9724)  
[lucas@labape.com.br](mailto:lucas@labape.com.br)

**Carlos Aznar-Blefari<sup>5</sup>**

[orcid.org/0000-0001-8665-5304](http://orcid.org/0000-0001-8665-5304)  
[psicoaznar@gmail.com](mailto:psicoaznar@gmail.com)

**Leticia Sanguinetti Czepielewski<sup>6</sup>**

[orcid.org/0000-0002-3898-0273](http://orcid.org/0000-0002-3898-0273)  
[czepielewski@gmail.com](mailto:czepielewski@gmail.com)

**Murilo Ricardo Zibetti<sup>7</sup>**

[orcid.org/0000-0002-8934-5640](http://orcid.org/0000-0002-8934-5640)  
[mrzibetti@gmail.com](mailto:mrzibetti@gmail.com)

**David Watson<sup>8</sup>**

[orcid.org/0000-0002-9605-0576](http://orcid.org/0000-0002-9605-0576)  
[db.watson@nd.edu](mailto:db.watson@nd.edu)

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**Resumo:** Nosso objetivo foi investigar diferenças entre sexos na interação e centralidade dos sintomas internalizantes usando análise de rede. Analisamos dados de 442 adultos brasileiros (221 homens e 221 mulheres), utilizando o Inventário de Sintomas de Depressão e Ansiedade - Versão Expandida (IDAS-II), uma medida de sintomas internalizantes alinhada ao Modelo Hierárquico de Psicopatologia (HiTOP). A análise de rede revelou semelhanças substanciais entre homens e mulheres, com ambos os grupos apresentando as associações mais fortes entre pares de sintomas, como euforia e bem-estar, e disforia e lassitude. A disforia emergiu como o sintoma mais central para ambos os sexos, destacando sua importância na psicopatologia internalizante. No entanto, algumas diferenças específicas de sexo foram observadas, com os homens apresentando associações

<sup>1</sup> Akershus University Hospital, Lørenskog, Noruega. / Universidade de Oslo, Oslo, Noruega.

<sup>2</sup> Universidade São Francisco (USF), Campinas, São Paulo, Brasil.

<sup>3</sup> Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brasil.

<sup>4</sup> Universidade Masaryk, Brno, República Tcheca.

<sup>5</sup> Universidade Tuiuti do Paraná (UTP), Curitiba, Paraná, Brasil.

<sup>6</sup> Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Rio Grande do Sul, Brasil.

<sup>7</sup> Universidade do Vale do Rio dos Sinos (Unisinos), São Leopoldo, Rio Grande do Sul, Brasil.

<sup>8</sup> Universidade de Notre Dame, South Bend, Indiana, Estados Unidos.

mais fortes entre sintomas como disforia e insônia, e intrusões traumáticas e esquiva. Nossos resultados sugerem uma estrutura amplamente compartilhada de sintomas internalizantes entre os sexos, embora intervenções direcionadas possam ser benéficas para tratar padrões específicos de sintomas em homens e mulheres.

**Palavras-chave:** sintomas internalizantes; diferença individuais; psicopatologia; análise de redes.

**Abstract:** Our aim was to investigate sex differences in the interplay and centrality of internalizing symptoms using network analysis. We analyzed data from 442 Brazilian adults (221 males and 221 females), utilizing the Inventory of Depression and Anxiety Symptoms - Expanded Version (IDAS-II), a measure of internalizing symptoms aligned with the Hierarchical Taxonomy of Psychopathology (HiTOP). Network analysis revealed substantial similarities between males and females, with both networks showing the strongest associations between symptom pairs such as euphoria and well-being, and dysphoria and lassitude. Dysphoria emerged as the most central symptom for both sexes, highlighting its importance in internalizing psychopathology. However, some sex-specific differences were noted, with males showing stronger associations between symptoms like dysphoria and insomnia, and traumatic intrusions and avoidance. Our findings suggest a largely shared structure of internalizing symptoms between sexes, though targeted interventions may be beneficial to address specific symptom patterns in males and females.

**Keywords:** internalizing symptoms; individual differences; psychopathology; network analysis.

**Resumen:** Nuestro objetivo fue investigar las diferencias de sexo en la interacción y centralidad de los síntomas internalizantes utilizando análisis de redes. Analizamos datos de 442 adultos brasileños (221 hombres y 221 mujeres), utilizando el Inventario de Síntomas de Depresión y Ansiedad - Versión Expandida (IDAS-II), una medida de síntomas internalizantes alineada con la Taxonomía Jerárquica de la Psicopatología (HiTOP). El análisis de redes reveló similitudes sustanciales entre hombres y mujeres, con ambas redes mostrando las asociaciones más fuertes entre pares de síntomas como euforia y bienestar, y disforia y lassitud. La disforia surgió como el síntoma más central en ambos sexos, destacando su importancia en la psicopatología internalizante. Sin embargo, se observaron algunas diferencias específicas por sexo, con los hombres mostrando asociaciones más fuertes entre síntomas como disforia e insomnio, y entre intrusiones traumáticas y evitación. Nuestros hallazgos sugieren una estructura en gran medida compartida de los síntomas internalizantes entre sexos, aunque intervenciones dirigidas podrían ser beneficiosas para abordar patrones específicos de síntomas en hombres y mujeres.

**Palabras clave:** síntomas internalizantes; diferencias individuales; psicopatología; análisis de redes.

## Introduction

Internalizing disorders, which encompass a broad range of conditions such as depression, anxiety, and related emotional dysregulation, are

highly prevalent and are known to cause significant social, economic, and individual burdens (Li et al., 2022; Yang et al., 2021). Research has consistently shown that females tend to exhibit a higher burden of internalizing symptoms compared to males, particularly in areas related to depression and anxiety (Bekkhus et al., 2023; Ma et al., 2022). These sex differences are thought to arise from a combination of biological, psychological, and social factors (Riecher-Rössler, 2017). Although numerous studies have focused on the prevalence of internalizing disorders in males and females, relatively few have examined how the interplay and centrality of symptoms might differ across sexes. Understanding these structural differences could provide valuable insights into the unique ways internalizing disorders manifest in males and females and may guide more tailored interventions. In this study, we explore sex differences in the interplay and centrality of internalizing symptoms through a network analysis approach, utilizing the self-report Inventory of Depression and Anxiety Scale - Expanded version (IDAS-II; Watson et al., 2012), a self-report measure aligned with the Hierarchical Taxonomy of Psychopathology (HiTOP) model (Kotov et al., 2017; 2021), to provide a broad analysis of symptom interaction across sexes.

Internalizing disorders have traditionally been conceptualized within categorical diagnostic models such as the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Classification of Diseases (ICD) (American Psychiatric Association, 2013; World Health Organization, 2018). Although these systems have contributed enormously to advances in prevalence estimates and the diagnostic process for mental disorders (Trull & Durrett, 2005; Widiger & Trull, 2007), they also present significant limitations. They classify all mental disorders into distinct categories, whereas current scientific evidence suggests that psychopathology exists on a continuum, blending with normal health functioning (Haslam, 2003; 2012; 2020). Furthermore, these frameworks exhibit low diagnostic reliability, struggle to capture the heterogeneous presen-

tations of individual disorders, and fail to account for the high comorbidity rates observed across conditions (Krueger & Piasecki, 2002; Widiger & Crego, 2018). A potential solution to the limitations of traditional taxonomies is the development of dimensional and quantitative nosologies that empirically organize various psychopathological manifestations (Krueger et al., 2018; Wright et al., 2013). A prominent contemporary effort in this direction is the HiTOP, a dimensional approach that seeks to reconceptualize mental disorders by organizing symptoms along a continuum of severity rather than in discrete categories.

The HiTOP proposes a dimensional, and hierarchically organized taxonomy based on empirical findings. It proposes the organization of psychopathology into six hierarchical levels: superspectra, spectra, subfactors, syndromes/disorders, components and maladaptive traits, and signs and symptoms. Within this hierarchy, the higher levels represent underlying processes shared by multiple clinical manifestations of psychopathology. Although the HiTOP proposal is relatively new, several studies have already demonstrated its reliability and utility (Cicero et al., 2024; Conway et al., 2019; Conway & Simms, 2020). Moreover, HiTOP has the potential to enhance clinical practice through multiple avenues, including assessment, treatment planning, and the monitoring of patient progress and outcomes (Cicero et al., 2024; Hopwood et al., 2020; Ruggiero et al., 2019).

In the HiTOP model, traditional internalizing diagnoses (e.g., depression, anxiety) and their associated symptoms are grouped under a broader spectrum, the internalizing spectrum, which reflects the shared variance and covariation among these conditions. The internalizing spectrum encompasses a variety of disorders characterized primarily by negative affectivity, hostility, intense emotional dysregulation, and associated forms of avoidance behavior (Kotov et al., 2021; Watson et al., 2022). This spectrum comprises five subfactors: sexual problems, eating pathology, fear, distress, and mania, each encompassing specific syndromes/disorders and maladaptive traits. For instance, social phobia, agoraphobia, specific

phobia, separation anxiety disorder, and panic disorder are linked to the fear subfactor. Problems involving sexual desire, arousal, orgasm, and pain, are encompassed by the sexual problems subfactor (Forbes et al., 2017). Depressive disorders, generalized anxiety disorder, and post-traumatic stress disorder fall under the distress subfactor. Type I and II bipolar disorders are grouped under the mania subfactor, which incorporates pathological traits from both the internalizing spectrum and the thought disorder spectrum (Kotov et al., 2017, 2021). Anorexia nervosa, binge eating disorder, and bulimia nervosa belong to the eating pathology subfactor. Finally, although obsessive-compulsive disorder does not clearly fit into any specific internalizing subfactor, it is still understood as a disorder associated with the internalizing spectrum (Watson et al., 2022). It is important to highlight that, although the HiTOP is a dimensional and hierarchical model of psychopathology, it still incorporates traditional diagnoses at the lower levels of its structure, as outlined in the description of the internalizing spectrum's components. The HiTOP does not reject these diagnoses; rather, it recognizes the limitations of how they are currently defined and proposes a reinterpretation and reorganization of their constituent symptoms based on empirical evidence of their covariation (Ruggiero et al., 2019; Conway et al., 2023). Thus, while previous studies based on categorical diagnoses do not fully capture the dimensional nature of the HiTOP framework, they are still conceptually related, given that the symptoms forming these traditional diagnoses are also represented within the HiTOP structure.

The clinical manifestations encompassed by the internalizing spectrum are of considerable importance, as they are highly prevalent in the global population and cause substantial social, individual, and economic burdens. The prevalence of depressive disorders is 4.4% worldwide, while the prevalence of anxiety disorders is 3.6% (WHO, 2017). Beyond their prevalence, disorders such as depression are among the leading causes of global disability, resulting in significant productivity

losses and an increased risk of suicide (Whiteford et al., 2013). Anorexia nervosa, for instance, has one of the highest mortality rates among mental disorders due to medical complications and suicide (Arcelus et al., 2011). Additionally, internalizing manifestations considerably increases costs for health systems, necessitating prolonged treatment, frequent consultations, hospitalizations, and continuous medication use (Whiteford et al., 2013). Consequently, this underscores the necessity of generating additional knowledge concerning the underlying mechanisms and various aspects of these disorders, including their functioning across diverse demographic groups.

Evidence suggests that sex differences exist across several mental disorders in terms of prevalence, symptomatology, course, and contributing factors. Such differences may be associated with both biological and environmental factors (Riecher-Rössler, 2017). Biological factors include endocrine issues (Kuehner, 2017), alterations in resting-state brain connectivity (Padgaonkar et al., 2020), and other neurobiological mechanisms. Environmental factors include gender-based violence (Oram et al., 2017), family conflict (Serio et al., 2022), and cultural patterns related to gender roles (Seedat et al., 2009). For instance, some models posit that activational effects of sex hormones on neural circuits create biological thresholds for psychopathology in men and women, in ways that alter vulnerability to internalizing syndromes (Hakin & Abramson, 2001; Pillerová et al., 2022). Complementing this, social theory emphasizes how culturally prescribed gender roles, through differential access to resources, expectations around emotional expression, and exposure to stressors like gender-based violence and family conflict, shape coping strategies and symptom presentation across the sexes (Farhane-Medina et al., 2022). Finally, evolutionary perspectives suggest that adaptive pressures have produced sex-skewed behavioral tendencies that map onto contemporary patterns of internalizing versus externalizing disorders (Martel, 2013). Together, these indicate why we observe both quantitative (e.g., higher prevalence rates) and qualitative (e.g.,

symptom expression and course) differences in internalizing disorders. Although we did not find any studies reporting sex differences using a broad conceptualization of the internalizing spectrum, several studies have reported both quantitative and qualitative differences in specific internalizing symptoms and syndromes across sexes.

Previous studies have demonstrated that females bear a higher burden of disorders characterized by internalizing symptoms, such as depression (Li et al., 2022) and anxiety (Yang et al., 2021). In addition to differing prevalence rates, there is also evidence of distinct manifestations of internalizing disorders. For instance, females diagnosed with generalized anxiety disorder (GAD) are more likely than males to also receive a diagnosis of major depressive disorder or bulimia nervosa, but less likely to be diagnosed with externalizing disorders such as substance use disorders or attention-deficit/hyperactivity disorder (McLean et al., 2011). Cognitive tendencies toward rumination, catastrophizing, and low self-esteem further amplify females' vulnerability to anxiety disorders (Chan et al., 2015; Norr et al., 2015). In depression, symptoms like dysphoria, changes in appetite, and sleep disturbances are more common in females, whereas patterns such as drug misuse and impulsivity are more prevalent in males (Cavanagh et al., 2017). Therefore, in addition to quantitative differences in prevalence, the manner of presentation and interconnection between symptoms may also vary according to sex, making network analysis of symptoms a useful approach to explore sex-differences in internalizing symptoms.

Network analysis can be an important resource to investigate the complexity of internalizing psychopathology. A network allows researchers to visualize the interplay between symptoms and their relative importance (i.e., centrality) within the network (e.g., which symptoms are connected to more symptoms, or which symptoms have stronger associations with other symptoms; Borsboom et al., 2021). Several studies on internalizing symptomatology have applied network analysis to investigate the interplay and centrality of inter-

nalizing symptoms (e.g., Bekkhus et al., 2023; Ma et al., 2022; Park et al., 2020; Sánchez-Hernández et al., 2022), including studies that used the IDAS or IDAS-II to assess the internalizing spectrum (de la Rosa-Cárceres et al., 2022; Eadeh et al., 2023; Funkhouser et al., 2020); however, only a few have investigated sex differences using this approach. Luo et al. (2024) reported that sex did not moderate a network of anxiety and depressive symptoms, suggesting a similar interplay of symptoms for both males and females. In contrast, Liu et al. (2023) identified sex differences in the network structure, centrality, and bridging symptoms of both internalizing and externalizing disorders in adolescents, as well as their longitudinal impact. Although these few studies provide valuable insights into sex-related differences in internalizing symptom networks, their focus has been largely restricted to anxiety and depression. To our knowledge, no study to date has examined sex differences in the broader internalizing symptom spectrum using a network approach.

Given these limitations in the literature, our focus in this study was to investigate the interplay and centrality of internalizing symptoms for males and females using a broader representation of internalizing symptoms. To achieve this, we used the IDAS-II (Watson et al., 2012), which is designed to assess internalizing symptomatology and is mainly aligned with the HiTOP model (Kotov et al., 2017), encompassing features of the fear, distress, and mania subfactors. Although previous studies have applied the IDAS-II for network analysis of internalizing symptoms (de la Rosa-Cárceres et al., 2022; Eadeh et al., 2023), none have focused specifically on potential sex differences. We aimed at investigating the (a) interplay of internalizing symptoms evaluated with the IDAS-II for males and females, (b) and the centrality of each symptom within the network for males and females.

## Methods

### Participants

We used a subset of the data from Machado et al. (2024), in which participants were recruited

through convenience sampling. The full dataset comprised 2,379 Brazilian adults ( $M = 30.59$ ;  $SD = 12.41$ ), with females constituting 89.8% of the sample. The data were collected using a Google Forms link shared on Facebook and WhatsApp. Given the imbalance in representativeness between males and females in the dataset, and considering that the primary aim of the present study is to accurately compare these groups, we retained all male participants and selected an equal number of female participants. The selection was performed using the MatchIt package in R (Ho et al., 2011), matching females to males based on similar levels of education, age, and ethnicity, in order to minimize potential confounding effects associated with these variables.

Our final sample, after the subsetting procedure, comprised 221 males and 221 females. In the male sample, the majority were college students (31.67%), followed by individuals with higher education (23.98%). Most males were white (66.51%), with a mean age of 30.24 years ( $SD = 12.31$ ), ranging from 18 to 72 years. The female sample, due to our selection method, retained sociodemographic characteristics very similar to those of the male sample. The age of females also ranged from 18 to 72 years ( $M = 29.78$ ;  $SD = 11.71$ ), with the majority being college students (31.67%) and white (66.97%).

## Measures

### *Socio-demographic questionnaire*

The socio-demographic questionnaire was developed for the present study and included questions about participants' biological sex, age, ethnicity, and educational background.

### *Inventory of Depression and Anxiety Symptoms – Expanded Version (IDAS-II; Watson et al., 2012).*

The IDAS-II is a self-report measure designed to assess internalizing psychopathology. Although it was developed before the development of the HiTOP model, it aligns with the model's concep-

tualization of the internalizing spectrum (Kotov et al., 2017). The IDAS-II comprises 99 items rated on a 5-point scale, ranging from 1 = not at all to 5 = extremely. The items are organized into 18 specific scales: Dysphoria ( $\alpha = 0.91$ ), Lassitude ( $\alpha = 0.84$ ), Insomnia ( $\alpha = 0.84$ ), Appetite Loss ( $\alpha = 0.81$ ), Appetite Gain ( $\alpha = 0.84$ ), Suicidality ( $\alpha = 0.90$ ), Traumatic Intrusions ( $\alpha = 0.87$ ), Traumatic Avoidance ( $\alpha = 0.81$ ), Panic ( $\alpha = 0.92$ ), Cleaning ( $\alpha = 0.87$ ), Ordering ( $\alpha = 0.81$ ), Checking ( $\alpha = 0.85$ ), Claustrophobia ( $\alpha = 0.85$ ), Social Anxiety ( $\alpha = 0.87$ ), Ill Temper ( $\alpha = 0.90$ ), Mania ( $\alpha = 0.85$ ), Euphoria ( $\alpha = 0.79$ ), and Well-Being ( $\alpha = 0.77$ ). This study used the Brazilian version of the IDAS-II (Machado et al., 2024). Previous studies support the psychometric properties of this measure's English and Brazilian Portuguese versions (Cervin et al., 2023; Machado et al., 2024; Watson et al., 2012).

## Procedure

The study was approved by a Research Ethics Committee at a Brazilian university and complied with the Declaration of Helsinki provisions regarding research on human participants (World Medical Association, 2013). All participants provided written informed consent before taking part in the study.

The data were collected using a Google Forms link shared on Facebook and WhatsApp. The study protocol included a sociodemographic questionnaire and the IDAS-II. To achieve our goal of comparing males and females and to ensure a more balanced sample, we selected a subset with an equal number of males and females. To achieve this, we used the *MatchIt* R package (Ho et al., 2011) to select a subsample of females with characteristics like those of the male sample regarding age, education, and ethnicity. This approach also helped control for sociodemographic confounders in our subsequent analysis.

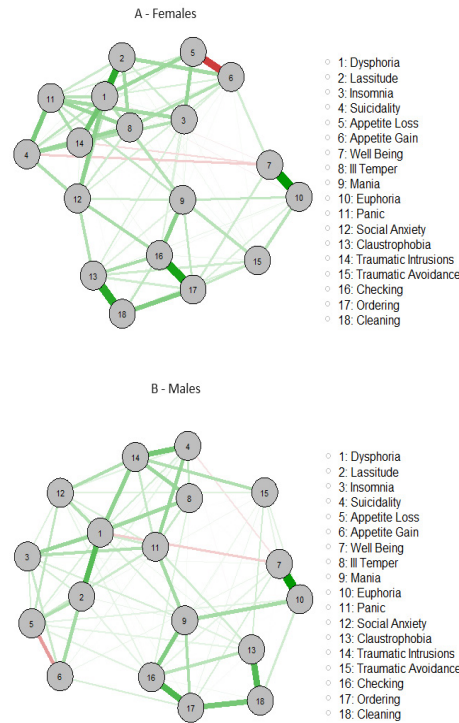
## Data analysis

Before conducting the network analysis, we transformed all the IDAS-II scale scores in  $z$  ( $M = 0$ ;  $SD = 1$ ) due to the different amplitudes of each scale. After the  $z$ -score transformation, we performed network analyses of internalizing symptoms using IDAS-II scales separately for the females and males in our sample, utilizing the EBICglasso model (Foygel & Drton, 2010). We chose this model because it combines the Least Shrinkage and Selection Operator (LASSO) penalization method, which employs regularization techniques to reduce spurious associations to zero, with the Extended Bayesian Information Criterion (EBIC) to select the optimal network from several generated by LASSO. We computed four centrality estimates (Bringmann et al., 2019; Robinaugh et al., 2016) for each network: strength (sum of the absolute values of edge weights), closeness (proximity of a node to all other nodes), betweenness (frequency in which a node resides on the shortest path connecting any two other nodes), and expected influence (which is based on the same calculus as the strength; however, it does not use absolute values). The network analysis and centrality estimates were performed using the *qgraph* (Epskamp et al., 2012) and *bootnet* (Epskamp et al., 2018) R packages. To achieve a more accurate comparison between the female and male networks, instead of relying solely on visual inspection, we performed comparisons using permutation tests with the *NetworkComparisonTest* R package (van Borkulo et al., 2023).

## Results

We conducted a network analysis on the internalizing symptoms as measured by the IDAS-II scales for both females and males. Figure 1 illustrates the network structure, while Table 1 details the connection weights for each sample.

**Figure 1 - Network of internalizing symptoms for females (A) and males (B)**



Note. The green lines represent positive associations, while the red lines represent negative associations between symptoms. The thickness of the lines indicates the strength of the associations, with thicker lines representing stronger associations and thinner lines representing weaker associations.

**Table 1 - Connection weights of internalizing symptoms in the network for females and males**

	Females																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2	.34																
3	.02	.08															
4	.10	.03	.00														
5	.16	.00	.17	.05													
6	.06	.15	.06	.00	-.32												
7	-.03	.00	.00	-.08	.00	.07											
8	.05	.15	.02	.16	.00	.13	.00										
9	.12	.01	.02	.00	.03	.00	.00	.06									
10	-.02	.00	.00	.00	.00	.00	.41	.00	.10								
11	.12	.08	.15	.21	.07	.00	.00	.16	.10	.00							
12	.18	.09	.00	.13	.00	.06	.00	.08	.08	.00	.00						
13	.00	.00	.07	.00	.00	.03	.00	.01	.05	.04	.00	.12					
14	.23	.14	.12	.14	.00	.04	-.06	.09	.00	.00	.13	.03	.00				
15	.03	.03	.02	.00	.00	.01	.00	.00	.11	.11	.00	.00	.08	.00			
16	.00	.00	.05	.00	.05	.01	.00	.00	.19	.02	.00	.14	.14	.03	.03		
17	.00	.00	.00	.00	.00	.00	.08	.00	.10	.06	.00	.00	.07	.00	.09	.37	
18	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.35	.01	.06	.10	.20

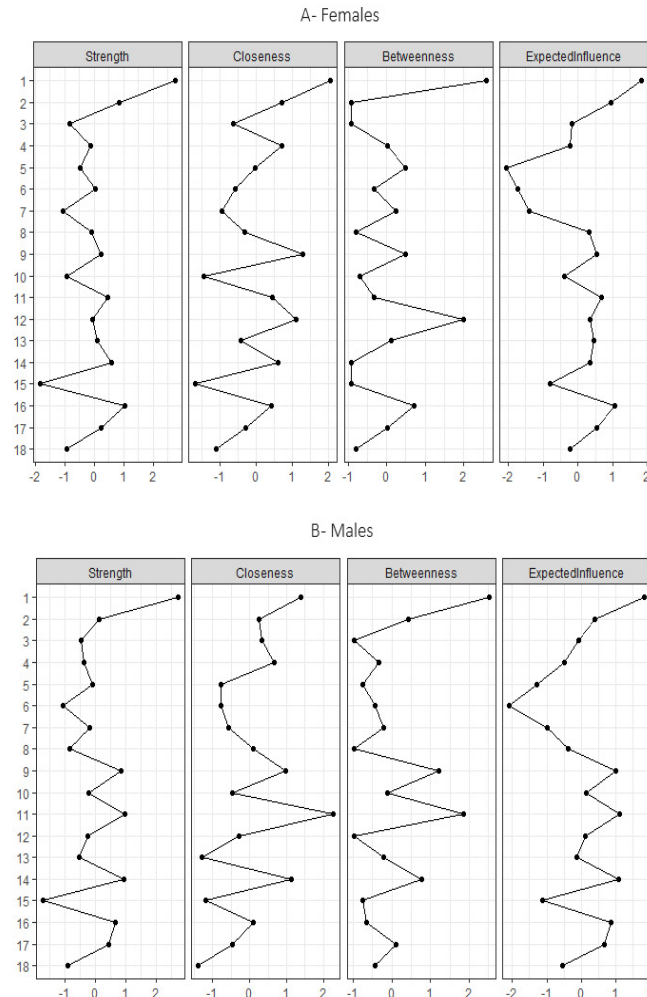
Males																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2	.33																
3	.20	.08															
4	.09	.05	.00														
5	.07	.16	.08	.03													
6	.06	.18	.11	.00	-.20												

Note. 1 = Dysphoria; 2 = Lassitude; 3 = Insomnia; 4 = Suicidality; 5 = Appetite Loss; 6 = Appetite Gain; 7 = Well Being; 8 = Ill Temper; 9 = Mania; 10 = Euphoria; 11 = Panic; 12 = Social Anxiety; 13 = Claustrophobia; 14 = Traumatic Intrusions; 15 = Traumatic Avoidance; 16 = Checking; 17 = Ordering; 18 = Cleaning.

Overall, we observed a similar pattern of connections in the networks. For both female and male networks, the strongest positive associations were observed between euphoria and well-being, checking and ordering, claustrophobia and cleaning, and dysphoria and lassitude. The strongest negative association was observed between appetite loss and appetite gain. Despite the overall similarity, some differences were noted. For instance, a negative association between traumatic intrusions and well-being was observed in the female network, but not in the male network.

To make a more accurate comparison between the network connections of females and males, we examined the omnibus test for network structure invariance to identify any differences in edge weights. The result was non-significant ( $M = 0.17$ ;  $p = 0.742$ ), suggesting an overall similarity between the edges of the networks. However, given the exploratory nature of our study, we further investigated potential small differences that might not have been detected in the overall test by examining each edge comparison individually.

Significant differences between edge weights were observed in only four cases: dysphoria and insomnia ( $E = 0.17$ ;  $p = 0.049$ ), lassitude and appetite loss ( $E = 0.16$ ;  $p = 0.030$ ), insomnia and social anxiety ( $E = 0.07$ ;  $p = 0.030$ ), and traumatic intrusions and traumatic avoidance ( $E = 0.15$ ;  $p = 0.030$ ). In all cases, the edges were stronger for males compared to females. Except for the first edge comparison (dysphoria and insomnia), which had a non-zero weight in both networks, the remaining edges had a zero weight in the female network but non-zero weights in the male network. A full table with all the comparisons is presented in the supplementary material. All centrality estimates converged, suggesting that dysphoria is the most central trait in the network for females. A similar pattern was observed for males, except for closeness, where the node with the strongest centrality was panic. Figure 2 presents the centrality estimates of strength, closeness, betweenness, and expected influence of the internalizing symptoms for both the female and male networks.

**Figure 2** - Centrality estimates of the IDAS-II networks for females (A) and males (B)

*Note.* 1 = Dysphoria; 2 = Lassitude; 3 = Insomnia; 4 = Suicidality; 5 = Appetite Loss; 6 = Appetite Gain; 7 = Well Being; 8 = Ill Temper; 9 = Mania; 10 = Euphoria; 11 = Panic; 12 = Social Anxiety; 13 = Claustrophobia; 14 = Traumatic Intrusions; 15 = Traumatic Avoidance; 16 = Checking; 17 = Ordering; 18 = Cleaning.

The nodes with the lowest centrality estimates varied across centrality measures and between samples. Traumatic avoidance had the lowest strength for both females and males. It also had the lowest closeness for females, but not for males, where cleaning had the lowest. Betweenness had more than one node with the lowest values: both males and females showed insomnia as one of the lowest. For females, lassitude, traumatic intrusions, and traumatic avoidance also had

low values, whereas for males, ill temper and social anxiety were among the lowest. Appetite loss showed the lowest expected influence for females, whereas appetite gain was the lowest for males. To gain a more accurate view of the differences in centrality, we performed an omnibus test of centrality invariance between networks. Table 2 presents the p-values for the comparison of the centrality estimates for each node between the networks.

**Table 2** - Centrality invariance between female and male networks

	Strength (p)	Closeness (p)	Betweenness (p)	Expected Influence (p)
1	.60	.87	.95	.92
2	.29	.90	<b>.04</b>	.28
3	.56	.18	.91	.54
4	.81	.63	.69	.97
5	.62	1	.18	.03
6	.23	.76	.93	.94
7	.37	.50	.70	.07
8	.15	.22	.31	.15
9	.22	.84	.63	.22
10	.37	.19	.41	.17
11	.35	.05	.10	.24
12	.85	.51	<b>.01</b>	.85
13	.35	.92	.68	.35
14	.29	.23	.06	<b>.04</b>
15	.99	.33	.84	.97
16	.78	.83	.41	.78
17	.60	.64	.96	.54
18	1	.51	.49	.81

Note. 1 = Dysphoria; 2 = Lassitude; 3 = Insomnia; 4 = Suicidality; 5 = Appetite Loss; 6 = Appetite Gain; 7 = Well Being; 8 = Ill Temper; 9 = Mania; 10 = Euphoria; 11 = Panic; 12 = Social Anxiety; 13 = Claustrophobia; 14 = Traumatic Intrusions; 15 = Traumatic Avoidance; 16 = Checking; 17 = Ordering; 18 = Cleaning. In bold are the p-values considered significant (<0.05).

Only three nodes showed significant differences in centrality estimates. The betweenness of lassitude and social anxiety differed significantly. Whereas lassitude had one of the lowest betweenness scores for females, this was not the case for males. The opposite was true for social anxiety, which presented one of the lowest betweenness for males, but not for females. Traumatic Intrusions were the only node that showed a significant difference in expected influence, with a higher influence in the male network.

## Discussion

Given the different prevalence and manifestation of internalizing symptoms between males and females (e.g., Li et al., 2022; Riecher-Rössler, 2017; Yang et al., 2021), we explored sex differences and similarities in the interplay and centrality of these symptoms through network analysis,

using the IDAS-II, a comprehensive measure of internalizing symptomatology aligned with the HiTOP model. Whereas previous studies have applied network approaches to analyze internalizing symptoms (e.g., Bekkhus et al., 2023; de la Rosa-Cárceles et al., 2022; Ma et al., 2022; Park et al., 2020; Sánchez-Hernández et al., 2022), only a few have focused on potential sex differences (Liu et al. 2023; Luo et al. 2024), and those that did, typically examined a narrower range of internalizing traits, often limited to anxiety and depression. Our study contributes to the literature by investigating sex differences in the interplay and centrality of internalizing symptoms using a more expansive measure. Overall, our findings revealed substantial similarity between the networks, suggesting a comparable interplay of internalizing symptoms in males and females. Likewise, centrality estimates were largely consistent across sexes, implying that the underlying

mechanisms contributing to these symptoms may be shared to a great extent. However, some specific differences were observed and will be discussed in detail. Our findings provide a broader understanding of internalizing symptomatology across sexes and offer insights into the structural and functional commonalities that could inform future research and clinical practice directed to males and females.

Our results regarding the interplay of internalizing symptoms demonstrated very similar associations between symptoms for both males and females, aligning with previous studies that focused primarily on anxiety and depression symptoms (Luo et al., 2024). Among both sexes, the strongest associations were observed for the following symptom pairs: euphoria and well-being, checking and ordering, claustrophobia and cleaning, dysphoria and lassitude, and appetite loss and appetite gain. These symptom pairs all belong to the same subfactors within the IDAS-II (Watson et al., 2012) and HiTOP (Kotov et al., 2021), so such associations are expected. Euphoria and well-being are part of the mania factor; checking and ordering, as well as claustrophobia and cleaning, fall under the fear/obsessions factor; and dysphoria and lassitude, along with appetite loss and appetite gain, are part of the distress factor of the IDAS-II (Watson et al., 2012).

Although our findings largely showed similar symptom interplay between groups, we did observe specific differences for four symptom pairs: dysphoria and insomnia, lassitude and appetite loss, insomnia and social anxiety, and traumatic intrusions and traumatic avoidance. In all these cases, the associations were stronger for males than for females, suggesting that these symptoms may tend to co-occur and influence one another more in males than in females. These differences might be attributed to biological, psychological, or social factors that differentially affect symptom expression in males and females. For instance, hormonal influences on sleep regulation (Paul et al., 2008) and appetite (Bautista et al., 2008) might contribute to the stronger associations observed in males. Moreover, cultural expectations around

the expression of distress (Cleary, 2012) could lead to variations in symptom reporting and interconnectedness. Machado et al. (2024) demonstrated measurement invariance across IDAS-II factors for males and females, indicating that the differences observed in our study are not due to differences on item parametrization between sexes. We report these results in an exploratory manner to provide a potential foundation for future studies that aim to investigate these specific features further. It is important to note, however that if we had adopted a more conservative significance level (i.e.,  $p < 0.001$ ), none of these pairs would have shown significant differences in association strength between the groups.

The centrality estimates indicated that dysphoria was the most relevant symptom for both males and females. The dysphoria scale on the IDAS-II represents the core affective and cognitive symptoms of depression and anxiety, including depressed mood, anhedonia, worry, worthlessness, guilt, hopelessness, psychomotor disturbance, and cognitive difficulties (Watson et al., 2007). Interestingly, dysphoria holds significant clinical utility because it contributes to functional impairment (de la Rosa-Cáceres et al., 2023) and can help differentiate between clinical and non-clinical samples (Stasik-O'Brien et al., 2019). Our findings regarding the centrality of dysphoria align with previous studies, where dysphoria was also one of the most influential symptoms in the network (de la Rosa-Cáceres et al., 2022; Eadeh et al., 2023; Funkhouser et al., 2020). Although prior research suggests that females are more likely to experience dysphoria (Cavanagh et al., 2017; Roberts & Gotlib, 1997) and display cognitive patterns associated with vulnerability to dysphoria, such as rumination, catastrophizing, and low self-esteem (Chan et al., 2015; Norr et al., 2015), our results indicate that dysphoria plays a major role in the internalizing network for both sexes. Given that central symptoms may serve as effective intervention targets (Anker et al. 2017; Borsboom & Cramer, 2013), our findings support the relevance of dysphoria as a potential entry point for transdiagnostic treatments aimed at

internalizing disorders in both males and females.

In contrast to our findings on dysphoria, suicidality did not emerge as a central symptom, diverging from results reported by Eadeh et al. (2023). This discrepancy is likely due to methodological differences: Eadeh and colleagues did not examine a “pure” internalizing network but rather included internalizing symptoms alongside Acceptance and Commitment Therapy (ACT) variables, which may have shaped the overall network structure. Notably, the authors themselves acknowledged that the centrality of suicidality was an unexpected result. Therefore, the absence of suicidality as a central node in our study appears to be in line with theoretical expectations and findings from studies focusing solely on internalizing variables (de la Rosa-Cárceles et al., 2022; Funkhouser et al., 2020).

Although our study provides important contributions, its findings should be considered in light of several limitations. First, the research participants were recruited from the general population rather than a true clinical sample. Second, data were collected online, which may have increased the likelihood of response errors and careless responses. Third, the sample size is relatively small. Fourth, the cross-sectional design prevents us from making causal inferences or examining the stability of symptom interplay over time. Future research should aim to replicate our findings in larger, more diverse samples, including clinical populations, to enhance the generalizability of these results. Additionally, exploring the impact of external factors such as stress, trauma, and life events on symptom networks could further illuminate the mechanisms underlying internalizing psychopathology. Moreover, although substantial evidence exists regarding dichotomized biological sex associations with psychopathology, research remains limited on how continuous dimensions of sexuality and gender expression could contribute to a better understanding of internalizing psychopathologies (Singh & Wendt, 2024), and we believe that future studies addressing this topic would also be important.

Our study contributes to the growing body of

literature utilizing network analysis to understand psychopathology. By applying network analysis, we were able to examine the interconnectedness of internalizing symptoms in a nuanced and detailed manner, shedding light on the symptom-level interplay and differences in influence between males and females. This approach aligns with dimensional models like HiTOP. Our findings indicate that males and females exhibit similar patterns in the interplay of internalizing symptoms, as well as comparable influences of individual symptoms within the overall network. A key finding is that dysphoria consistently emerged as the most central symptom for both sexes, underscoring its pivotal role in the internalizing spectrum. Although our results primarily point to similarities between the sexes, we also observed specific differences, suggesting that, despite a shared core of internalizing symptoms, interventions may need to be tailored to address sex-specific symptom patterns.

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### Gisele Magarotto Machado

Doutora, atua como Pesquisadora de Pós-Doutorado na Noruega, duplamente afiliada ao Akershus University Hospital e ao PROMENTA Research Center na University of Oslo.

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---

**Ariela Raissa Lima-Costa**

Doutora, afiliada ao Departamento de Psicologia da Universidade São Francisco, no Brasil.

---

**Marcela Mansur-Alves**

Doutora, desenvolve suas atividades acadêmicas no Programa de Pós-Graduação em Psicologia: Cognição e Comportamento, que faz parte do Departamento de Psicologia da Universidade Federal de Minas Gerais (Brasil).

---

**Bruno Bonfá-Araujo**

Doutor, atua como pesquisador de Pós-doutorado na República Tcheca, afiliado à Masaryk University, e é professor associado no Brasil, vinculado à Universidade Tuiuti do Paraná.

---

**Lucas de Francisco Carvalho**

Doutor, vinculado ao Departamento de Psicologia da Universidade São Francisco, no Brasil.

---

**Carlos Aznar-Blefari**

Doutor, atua no Departamento de Psicologia Forense da Universidade Tuiuti do Paraná, no Brasil.

---

**Leticia Sanguinetti Czepielewski**

Doutora, filiada ao Programa de Pós-Graduação em Psicologia, no Departamento de Psicologia do Desenvolvimento e da Personalidade da Universidade Federal do Rio Grande do Sul (Brasil).

---

**Murilo Ricardo Zibetti**

Doutor, vinculado ao Programa de Pós-Graduação em Psicologia, no Departamento de Psicologia da Universidade do Vale do Rio dos Sinos, no Brasil.

---

**David Watson**

Doutor, possui afiliação internacional com o Department of Psychology da University of Notre Dame, nos Estados Unidos.

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**Endereço para correspondência****Gisele Magarotto Machado**

Akershus University Hospital  
Division of Mental Health Services  
Sykehusveien 25, 1478

R&D Department  
Lørenskog, Noruega

**Ariela Raissa Lima-Costa**

Universidade São Francisco  
Rua Waldemar César da Silveira, 105  
Jardim Cura D'Ars (Swift), 13045-510  
Campinas, SP, Brasil

**Marcela Mansur-Alves**

Universidade Federal de Minas Gerais  
Programa de Pós-Graduação em Psicologia: Cognição e Comportamento  
Av. Antônio Carlos, 6627  
Campus Pampulha, 31270-901  
Belo Horizonte, MG, Brasil

**Bruno Bonfá-Araujo**

Masaryk University, Faculty of Social Studies.  
Interdisciplinary Research Team on Internet and Society,  
Faculty of Social Studies  
Jostova 218  
Brno-stred, 60200  
Brno, República Tcheca

**Lucas de Francisco Carvalho**

Universidade São Francisco  
Rua Waldemar César da Silveira, 105  
Jardim Cura D'Ars (Swift), 13045-510  
Campinas, SP, Brasil

**Carlos Aznar-Blefari**

Universidade Tuiuti do Paraná  
Programa de Pós-Graduação em Psicologia Forense  
Rua Padre Ladislau Kula, 395  
Santo Inácio, 82010-210  
Curitiba, PR, Brasil

**Leticia Sanguinetti Czepielewski**

Universidade Federal do Rio Grande do Sul  
Rua Ramiro Barcelos, 2600  
Floresta, 90610-264  
Porto Alegre, RS, Brasil

**Murilo Ricardo Zibetti**

Universidade do Vale do Rio dos Sinos

Programa de Pós-graduação em Nutrição, Alimentos e Saúde

Avenida Unisinos, 950, Setor F, Prédio F03

Cristo Rei, 93022-750

São Leopoldo, RS, Brasil

**David Watson**

University of Notre Dame

Department of Psychology

Holy Cross Dr, Notre Dame, Indiana, USA 46556

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