



A bibliometric analysis of 10 years of research on symptom networks in psychopathology and mental health

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ABSTRACT

Psychopathology networks consist of aspects (e.g., symptoms) of mental disorders (nodes) and the connections between those aspects (edges). This article aims to analyze the research literature on network analysis in psychopathology and mental health for the last ten years. Statistical descriptive analysis was complemented with two bibliometric techniques: performance analysis and co-word analysis. There is an increase in publications that has passed from 1 article published in 2010 to 172 papers published in 2020. The 398 articles in the sample have 1,910 authors in total, being most of them occasional contributors. The Journal of Affective Disorders is the one with the highest number of publications on network analysis in psychopathology and mental health, followed by the Journal of Abnormal Psychology and Psychological Medicine stand out. The present study shows that this perspective in psychopathology and mental health is a recent field of study, but with solid advances in recent years from a wide variety of researchers, mainly from USA and Europe, who have extensively studied symptom networks in depression, anxiety, and post-traumatic stress disorders. However, gaps are identified in other psychological behaviors such as suicide, populations such as the elderly, and gender studies.

1. Introduction

The guidelines provided by the traditional diagnostic classifications in use, such as the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 2013) and the International Statistical Classification of Diseases and Related Health Problems (ICD) (World Health Organization, 2004), have helped clinicians in establishing whether a person's mental health problems meet all the criteria for diagnosing a psychological disorder. However, despite their utility, these classifications are not free of controversy, as they represent a traditional categorical approach (Blanco et al., 2019). Besides the widespread criticism of the latest version of DSM 5 (Frances and Nardo, 2013; Kamens et al., 2017), these classifications also present considerable limitations for their use as the only strategy for the design of mental health treatments, due to the lack of functional value (Muñoz et al., 2019). Neither do they solve the high comorbidity of symptoms (Cramer et al., 2010) nor the low inter-rater reliability found (Contreras, 2021; Ramos, 2016). In sum, they do not solve the debate on conceptualizing mental disorders dimensionally or categorically (McNally, 2016).

The symptom-network perspective in psychopathology questions the fact that diagnostic criteria within the same mental disorder are distinct of each other (Borsboom, 2017). It also points out that variables traditionally considered as indicators of latent constructs should be taken as autonomous causal variables in a network of dynamic systems. *Network Analysis* (NA) has been used to identify and examine patterns of statistical association in multivariate psychological data with different data structures (Borsboom et al., 2021) long been used in various disciplines such as the social and behavioral sciences (Nettleton, 2013; Su et al., 2020; Wasserman and Faust, 1994). Nevertheless, its use is relatively new for understanding the dynamic interactions between psychopathological symptoms (Borsboom and Cramer, 2013). From the network perspective, individual symptoms are represented as nodes, and connections are placed between symptoms that tend to co-occur, forming a particular psychopathology network. This analysis in psychopathology provides a visual description of the complex associations between symptoms, which can be interpreted as partial correlations. Thus, instead of an underlying entity producing symptoms classified into categories, the origin of the disorders would be the covariation between symptoms and their dynamic causal interactions. Hence, considering

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many more variables and aspects that were not traditionally included in diagnostic classifications.

The emergence of these analyses has caused a shift in the approach to mental health problems. In the last decade, there has been a significant increase in research carried out from a network perspective. Two recent reviews summarize the research carried out on this subject. [Contreras et al. \(2019\)](#) conducted a systematic review on 65 studies, concluding that NA helps to identify, in an innovative way, important aspects of psychopathology such as the centrality of symptoms in a given disorder, as well as the mutual dynamics between symptoms. Also, [Robinaugh et al. \(2020\)](#) provided a broad overview, suggesting the identification of solid empirical phenomena and the development of formal explanatory theories. However, none of these reviews discusses how NA literature has evolved, nor do they examine its main actors (researchers, institutions, journals, etc.), or identify the most influential articles per research topic.

This article complements the aforementioned reviews with a bibliometric analysis on psychopathology and mental health research based on NA carried out over the last decade. The study encompasses the evolution of NA literature, identifying the most influential authors, the journals with the highest number of publications, the origin of the articles (institutions and countries), as well as the most studied topics within NA in mental health and their relationships.

2. Methods

According to the directions given by [Börner et al. \(2003\)](#), [Moher et al. \(2009\)](#), and [Cobo et al. \(2011\)](#), we followed the systematic procedure represented in [Fig. 1](#) to analyze the literature on NA. First, a sample of papers was retrieved from the Web of Science (WoS) database. The initial sample was filtered to exclude false positives and expanded with relevant missed papers. Then, the bibliographic data was normalized and examined using descriptive statistics, performance analysis, and co-word analysis.

2.1. Data retrieval

In practice, collecting the whole *population* of articles published on a given topic is unfeasible ([Kitchenham, 2007](#); [Wohlin et al., 2013](#)). Accordingly, this first step aims to obtain a *representative sample* with a view to generalizing the analysis results for the population. To do so, we conducted the following query on WoS Core Collection, retrieving 407 articles.

TS=((network NEAR/0 analys?s)
AND (symptom* OR diagnos* OR psychopat* OR depress* OR anxiety OR psychosis
OR bipolar OR schizophrenia OR dementia OR “obsessive compulsive” OR OCD OR
(post NEAR/0 “traumatic stress disorder”) OR PTSD OR “personality disorder”))
AND SU=(Psychology OR Psychiatry)
NOT TS=(neur* OR gene\$ OR “brain network” OR “social network” OR “social media analys?s” OR “text mining” OR “data mining” OR

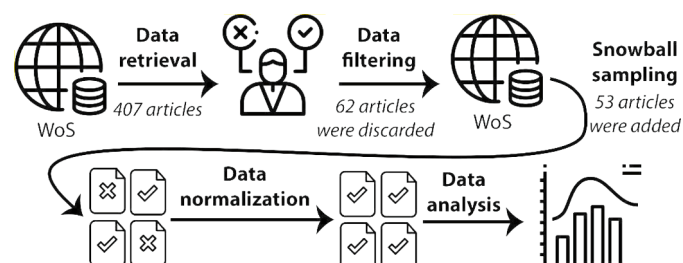


Fig. 1. Bibliometric workflow followed in our analysis.

“content analys?s” OR “semantic network analys?s” OR “thematic network analys?s” OR cancer OR HIV OR metabol*)

The query includes the next WoS operators (highlighted in red):

- *Field operators* that limit the scope of the search. *TS* stands for “topic” and restricts the search to the articles’ title, abstract, and keywords. *SU* stands for “research area” and looks into the WoS subject categorization scheme.
- *Boolean operators* that link the terms in the query. Besides the propositional logic operators (*AND*, *OR*, and *NOT*), we used the proximity operator *t1 NEAR/N t2*, which finds articles whose terms *t1* and *t2* are within *N* number of words of each other. Accordingly, *post NEAR/0 “traumatic stress disorder”* incorporates the strings “post-traumatic stress disorder”, “post-traumatic stress disorder”, and “posttraumatic stress disorder”.
- *Wildcards* that account for unknown characters. * means any group of characters ? is any single character, and \$ refers to zero or one character (excluding spaces).

The query was successively polished until a convenient balance between coverage and absence of false positives was accomplished. Also, Sugimoto and Lariviere’s recommendations ([Sugimoto and Larivière, 2018](#)) were followed, and thus WoS was selected in favor of other databases (e.g., Scopus, Google Scholar, etc.) due to its data quality reputation and suitability for secondary studies covering long time periods.

2.2. Data filtering

The query was run on February 2, 2021, and the sample obtained was filtered according to the following exclusion criteria used: (1) Non-peer reviewed articles; (2) Articles not written in English; (3) Articles not focused on the psychological/psychiatric application of NA. This third criterion includes articles whose main objective is to describe the methodology of NA. As a result, 62 articles were discarded.

To prevent missing relevant articles, Wohlin’s snowballing guidelines ([Wohlin et al., 2013](#)) were followed. Snowballing is an iterative process where new papers are identified in each subsequent cycle by examining the references of the articles that are already in the sample. As a result, our paper collection was enlarged with 53 new papers and, therefore, the final sample included 398 articles.

Before analyzing the sample, bibliographic data typically require to be normalized ([Cobo et al., 2011](#)) since a researcher may appear in several records with slightly different names, or distinct keywords must be treated as synonyms in the further analysis. For example, in the scope of this paper, the keywords *children*, *child*, *preschool children*, *preadolescent*, *adolescence*, *adolescents*, etc. were grouped as *children/adolescents*.

2.3. Data analysis

Statistical descriptive analysis was complemented with two bibliometric techniques: *performance analysis* and *co-word analysis*.

Performance analysis measures research impact. In particular, we have followed Martinez et al.’s recommendations ([Martínez et al., 2014](#)) to identify the most impacting articles by using the *h-index* ([Hirsch, 2005](#)). To do so, the *h-index* is defined as follows: “a research area has index *h* when *h* of its *n* articles have at least *h* citations each, and the remaining *n-h* articles have less than or equal to *h* citations each”. Those articles with a number of citations greater than or equal to the *h-index* are considered the *classics* of the area.

Co-word analysis ([Coulter et al., 1998](#)) helps to identify the most relevant research topics and their inter-relationship by measuring the co-occurrence frequency of pairs of an article’s keywords. We also used co-word analysis to examine the collaboration networks among the most prolific authors, obtaining a graph whose nodes and edges represent researchers and number of co-authored articles, respectively.

We carried out data normalization, performance analysis, and co-word analysis with the open-source tool SciMAT, available at <https://sci2s.ugr.es/scimat/>. The raw bibliographic data was retrieved from WoS, the normalized database in SciMAT format is publicly available at Zenodo (<https://doi.org/10.5281/zenodo.4614134>).

3. Results

3.1. Number of publications and evolution over time

The results of our data collection resulted in 398 articles on NA in psychopathology published in the last 10 years. As Fig. 2 shows, the publication rate has grown dramatically from 2010 to nowadays.

3.2. Article citations

The histogram in Fig. 3 shows the articles' distribution according to their citation number. This distribution is extremely right-skewed, being 4 and 21.74 the median and mean, respectively. Whereas 22.36% of the articles have not received any citation at all (see the highest bar on the left), a few papers that will be summarized in Table 1 have 42 or more citations (see the low bars on the right).

Fig. 4 distinguishes among the number of citations (i) in total, (ii) excluding self-citations, and (iii) restricting the citing papers to those in the sample. The bottom bar shows that 66.94% of the citations come from the collaborative community that has published the article sample.

3.3. Most influential articles and prolific journals

Table 1 lists the most influential articles on NA and psychopathology, i.e., the area's classics. According to our sample, the area's h-index is 42, thus Table 1 summarizes the 42 articles that have received at least 42 citations. Fig. 5 shows the top 15 journals that have published the greatest number of articles, in particular the *Journal of Affective Disorders*, and *Journal of Abnormal Psychology and Psychological Medicine*.

3.4. Most productive authors

The 398 articles in our sample have 1910 authors in total. Most of them are occasional contributors. Indeed, 83.98% of the authors have published a single paper, and only 3.3% have written four or more articles. This authorship distribution is not surprising as it approximately follows Lotka's law (Lotka, 1926), an important bibliometric principle which states that the number of authors with n papers tends to be inversely proportional to n^2 .

Fig. 6 shows the collaboration patterns among the most prolific authors. There is a node for each author with at least four articles. Node size is proportional to the number of papers authored within the sample. An edge linking two nodes represents the corresponding researchers who have co-authored some article. Edge thickness is proportional to the number of co-authored articles. Nodes and edges are colored according to the collaborating authors' groups identified with *Leiden's algorithm* (Traag et al., 2019).



Fig. 2. Number of articles per year.

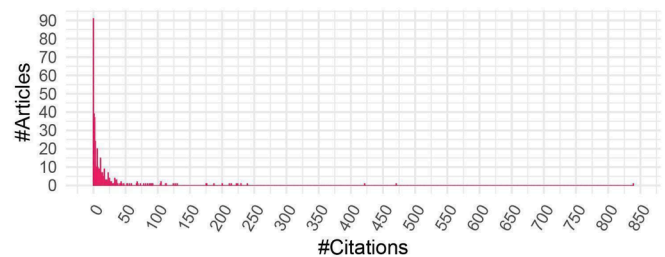


Fig. 3. Article distribution according to their number of citations.

3.5. Most relevant countries and institutions

Fig. 7 shows the number of articles published per country. Most research is concentrated in the USA, with 44.88% of all the articles. The top five countries after the USA are the Netherlands (18.37%), the UK (11.38%), Germany (7.64%), Belgium (7.32%), and Italy (6.5%). Fig. 8 shows the institutions with the highest number of publications, in particular, the University of Amsterdam, Harvard, and Groningen.

3.6. Keyword analysis

The graph in Fig. 9 shows the most frequent article keywords (represented by nodes) and their co-occurrence relationships. Node size is proportional to the number of papers containing the keyword. An edge linking two nodes shows the corresponding keywords that appear together in some article; edge width accounts for the number of articles where the keywords co-occur. Keyword examination shows that within the articles on NA in psychopathology and mental health, the most frequently studied categories are: *methodologies* (80.55%), *mood disorders* (56.36%), *psychological variables* (43.14%), *therapies* (34.16%), and *anxiety disorders* (29.93%). In contrast, the topics with the least amount of research are: *older adults* (1%), *suicide and self-harm* (4.24%), and *gender studies* (6.48%). Table 2 summarizes (i) each keyword's bibliometric indicators (number and percentage of articles including the keyword, and h-index and average citations the papers with the keyword have received), and (ii) the most cited articles per keyword (the last column follows the notation *reference[#citations]*). It is worth noting that, just as a keyword may be used in many articles, an article typically includes more than a single keyword. For example, in Table 2, (Borsboom and Cramer, 2013) is classified into five categories because it includes the keywords (i) *mood disorders*, (ii) *children and/or adolescents*, (iii) *other disorders*, (iv) *psychological variables*, and (v) *methodologies*.

4. Discussion

This article aims to analyze the research literature on NA in psychopathology and mental health for the last ten years. To do so, bibliometric techniques have been applied, analyzing a sample of 398 articles that represents the increasing literature, which has passed from 1 article published in 2010 to 172 papers published in 2020. This dramatic increase shows the scientific community's growing interest in the study of symptom NA in psychopathology. This may happen because the symptom network perspective is a categorical classification alternative that can overcome some of their disadvantages (Borsboom, 2017; Frances and Nardo, 2013; Kamens et al., 2017; McNally, 2016; Muñoz et al., 2019).

For the sake of objectiveness, our analysis has followed a systematic and partially automatized workflow. We have tried to mitigate subjectivity by using clear and well-justified criteria: (i) WoS was selected because it provides the highest quality bibliometric indicators (Sugimoto and Larivière, 2018); (ii) the WoS query was increasingly developed until a convenient balance between coverage and absence of false positives was achieved; and (iii) article filtering and keyword

Table 1
Most influential articles on NA and psychopathology.

Title	Reference	#Citat.
Network analysis: An Integrative Approach to the Structure of Psychopathology	(Borsboom and Cramer, 2013)	839
Comorbidity: A network perspective	(Cramer et al., 2010)	471
A network theory of mental disorders	(Borsboom, 2017)	422
The Small World of Psychopathology	(Borsboom et al., 2011)	239
State of the aRt personality research: A tutorial on network analysis of personality data in R	(Costantini et al., 2015)	229
Depression is not a consistent syndrome: An investigation of unique symptom patterns in the STAR*D study	(Fried and Nesse, 2015)	224
Mental Disorders as Causal Systems: A Network Approach to Posttraumatic Stress Disorder	(McNally et al., 2015)	222
Deconstructing the construct: A network perspective on psychological phenomena	(Schmittmann et al., 2013)	214
A Network Approach to Psychopathology: New Insights into Clinical Longitudinal Data	(Bringmann et al., 2013)	211
Association of Symptom Network Structure With the Course of Longitudinal Depression	(van Borkulo et al., 2015)	200
Can network analysis transform psychopathology?	(McNally, 2016)	187
What are 'good' depression symptoms? Comparing the centrality of DSM and non-DSM symptoms of depression in a network analysis	(Fried et al., 2016)	176
Moving Forward: Challenges and Directions for Psychopathological Network Theory and Methodology	(Fried and Cramer, 2017)	175
Revealing the dynamic network structure of the Beck Depression Inventory-II	(Bringmann et al., 2015)	130
Identifying Highly Influential Nodes in the Complicated Grief Network	(Robinaugh et al., 2016)	127
The Impact of Individual Depressive Symptoms on Impairment of Psychosocial Functioning	(Fried and Nesse, 2014)	124
Replicability and Generalizability of Posttraumatic Stress Disorder (PTSD) Networks: A Cross-Cultural Multisite Study of PTSD Symptoms in Four Trauma Patient Samples	(Fried et al., 2018)	113
A Network Approach to Psychosis: Pathways Between Childhood Trauma and Psychotic Symptoms	(Isvoranu et al., 2017)	112
Measuring gratitude in youth: assessing the psychometric properties of adult gratitude scales in children and adolescents	(Froh et al., 2011)	105
Major Depression as a Complex Dynamic System	(Cramer et al., 2016)	105
From Loss to Loneliness: The Relationship Between Bereavement and Depressive Symptoms	(Fried et al., 2015)	104
The Network Structure of Symptoms of the Diagnostic and Statistical Manual of Mental Disorders	(Boschloo et al., 2015)	92
A network analysis of DSM-5 posttraumatic stress disorder symptoms and correlates in US military veterans	(Armour et al., 2017)	91
Acute and Chronic Posttraumatic Stress Symptoms in the Emergence of Posttraumatic Stress Disorder: A Network Analysis	(Bryant et al., 2017)	89
Network analysis of Persistent Complex Bereavement Disorder in Conjugally Bereaved Adults	(Robinaugh et al., 2014)	87
Exploring the Idiographic Dynamics of Mood and Anxiety via Network analysis	(Fisher et al., 2017)	84
A Complex Network Perspective on Clinical Science	(Hofmann et al., 2016)	81
The pathoplasticity of dysphoric episodes: differential impact of stressful life events on the pattern of depressive symptom inter-correlations	(Cramer et al., 2012)	78
Brain disorders? Not really: Why network structures block reductionism in psychopathology research	(Borsboom et al., 2019)	73
Exploring the underlying structure of mental disorders: cross-diagnostic differences and	(Wigman et al., 2015)	69

Table 1 (continued)

Title	Reference	#Citat.
similarities from a network perspective using both a top-down and a bottom-up approach		
A Network Approach to Environmental Impact in Psychotic Disorder: Brief Theoretical Framework	(Isvoranu et al., 2016)	68
Network analysis of substance abuse and dependence symptoms	(Rhemtulla et al., 2016)	68
An integrative network approach to social anxiety disorder: The complex dynamic interplay among attentional bias for threat, attentional control, and symptoms	(Heeren and McNally, 2016)	67
Repetitive Behaviors in Autism and Obsessive-Compulsive Disorder: New Perspectives from a Network analysis	(Ruzzano et al., 2015)	59
The Core Symptoms of Bulimia Nervosa, Anxiety, and Depression: A Network analysis	(Levinson et al., 2017)	56
A network approach to the comorbidity between posttraumatic stress disorder and major depressive disorder: The role of overlapping symptoms	(Afzali et al., 2017)	53
Co-morbid obsessive-compulsive disorder and depression: a Bayesian network approach	(R J McNally et al., 2017a)	52
A Bayesian network analysis of posttraumatic stress disorder symptoms in adults reporting childhood sexual abuse	(R J McNally et al., 2017b)	47
The association of posttraumatic stress disorder, complex posttraumatic stress disorder, and borderline personality disorder from a network analytical perspective	(Knefel et al., 2016)	44
A network perspective on comorbid depression in adolescents with obsessive-compulsive disorder	(P.J. Jones et al., 2018)	43
Application of network analysis to identify interactive systems of eating disorder psychopathology	(Forbush et al., 2016)	43

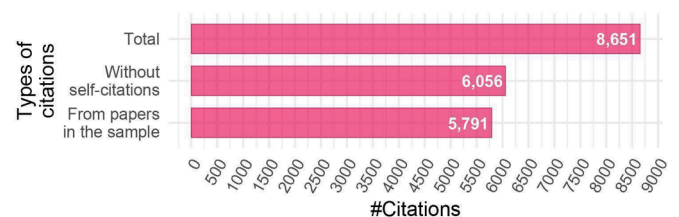


Fig. 4. Number of citations (i) in total, (ii) excluding self-citations, and (iii) restricting the citing papers to those in the sample.

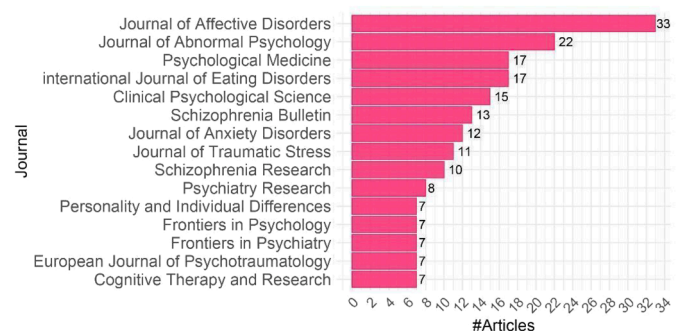


Fig. 5. Journals that have published the highest number of articles.

standardization were based on the consensual agreement among three of us.

Regarding the journals with the highest number of publications on NA in psychopathology and mental health, the *Journal of Affective Disorders* and the *Journal of Abnormal Psychology and Psychological Medicine*

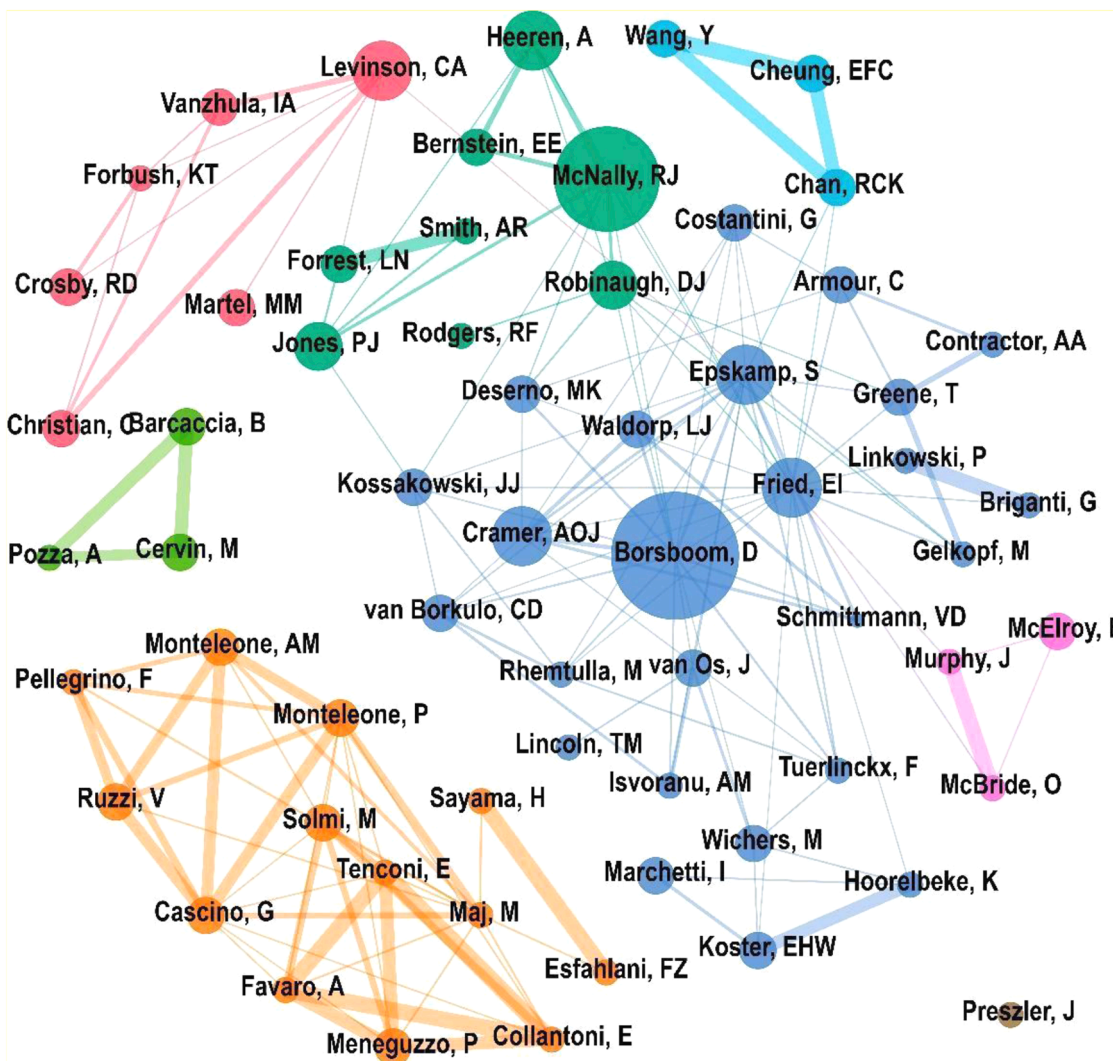


Fig. 6. Collaboration networks of the authors with four or more papers.

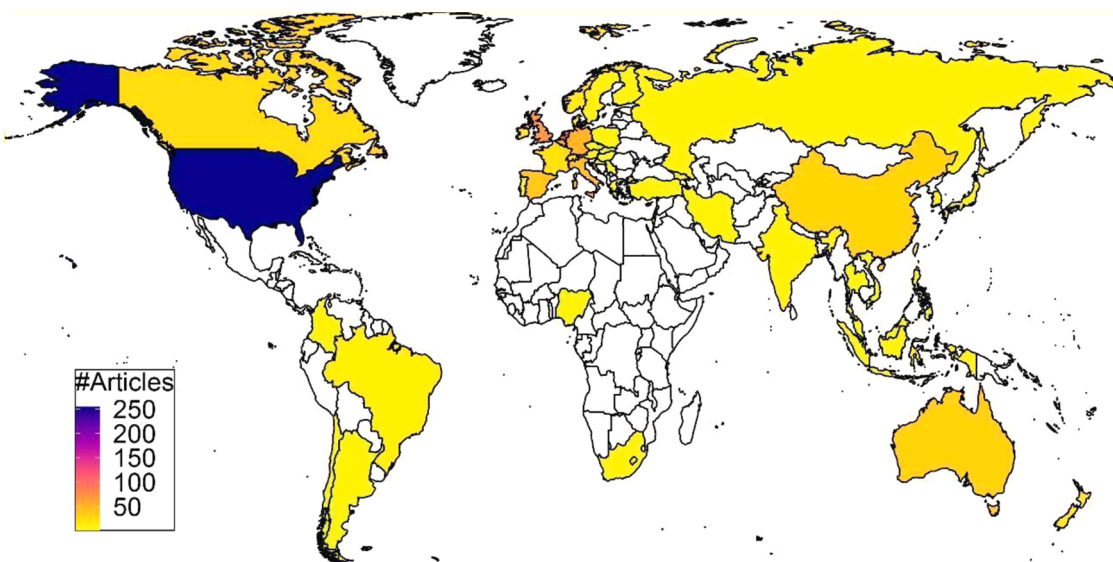


Fig. 7. Article distribution per country.

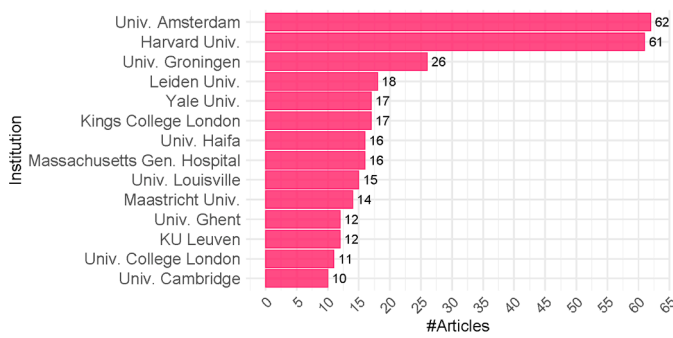


Fig. 8. Institutions that have published a higher number of articles.

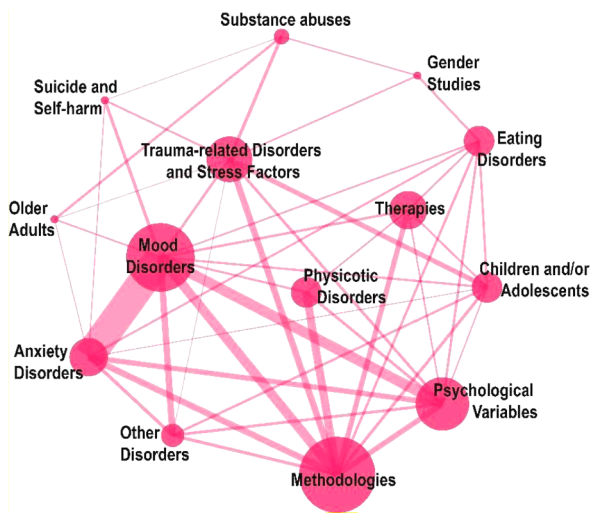


Fig. 9. Keyword co-occurrence graph.

stand out. Out of the total number of articles published on the subject, 324 refer to NA in mood disorders, which would explain the great interest of the Journal of Affective Disorders in publishing information on that subject.

Concerning the researchers' involvement and collaboration, the 398 articles in our sample have 1910 authors in total, but most of them are occasional contributors. A core of researchers (3.3% of all authors) has written four or more articles. These authors collaborate in groups. The most relevant groups are formed by (i) Borsboom, D., Fried, E.I., Epskamp, S., Cramer, AOJ. et al., (ii) Cascino, G., Monteleone, AM., Solmi, M., Ruzzi, V. et al., (iii) Levinson, CA., Crosby, RD., Christian, C., Vanzhula, IA. et al., (iv) Cheung, EFC., Wang, Y., and Chan, RCK., (v) McNally, R.J., Robinaugh, DJ., Jones, P.J., Heeren, A. et al., and (vi) Cervin, M., Pozza, A. and Barcaccia, B. The proliferation of research groups, most of them composed of more than 7 authors, highlights the enormous number of researchers and research groups on the topic of symptom networks in psychopathology.

Regarding the articles' origin, most research concentrates on the USA, with 44.88% of all articles, followed by the Netherlands (18.37%), the UK (11.38%), Germany (7.64%), Belgium (7.32%), and Italy (6.5%). Among the 7 universities that have published the most articles on the subject are logically some of the major American universities (Harvard University or Yale University). In contrast, it is worth noting that the institution with the highest number of publications is the University of Amsterdam, with the University of Groningen and Leiden in third and fifth places. This again underlines the importance and growing interest in the subject, present both in the USA and in Europe. It is worth mentioning the important role that the Netherlands and its authors (Borsboom, Cramer, and others) have played.

Table 2
Most relevant categories and their associated articles.

Category	N	%	h-index	#Citat.	Average #Citat.	Main articles
Mood disorders	324	80	33	8276	25.5	(Borsboom and Cramer, 2013)[839]; (Cramer et al., 2010)[471]; (Borsboom, 2017)[422] (Borsboom et al., 2011) [239] (Fried and Nesse, 2015) [224]
Anxiety disorders	120	29	23	2514	20.95	(Cramer et al., 2010) [471] (Borsboom et al., 2011) [239] (Isvoranu et al., 2017) [112] (Cramer et al., 2016)[105] (Mitchell et al., 2017) [41] (van de Grift et al., 2016) [28]
Gender studies	26	6	10	253	9.7	(Borsboom and Cramer, 2013)[839] (Froh et al., 2011) [105] (Ruzzano et al., 2015) [59] (R J McNally et al., 2017a) [47] (P.J. Jones et al., 2018) [43]
Children and/or adolescents	92	22	15	1589	17.3	(Borsboom and Cramer, 2013)[839] (Cramer et al., 2010) [471] (Isvoranu et al., 2017) [112] (Wigman et al., 2015) [69] (Isvoranu et al., 2016) [68] (Wigman et al., 2017) [33]
Other disorders	49	12	13	2140	43.6	(Cramer et al., 2010) [471] (McNally et al., 2015) [222] (Fried and Cramer, 2017)[175] (Robinaugh et al., 2016) [127]
Psychotic disorders	56	13	12	922	16.5	(Cramer et al., 2010) [471] (McNally et al., 2015) [222] (Fried and Cramer, 2017)[175] (Robinaugh et al., 2016) [127]
Trauma related disorders and stress factors	102	25	22	2588	25.4	(Cramer et al., 2010) [471] (McNally et al., 2015) [222] (Fried and Cramer, 2017)[175] (Robinaugh et al., 2016) [127]
Substance abuse and other	31	7	11	719	23.2	(Cramer et al., 2010) [471]

(continued on next page)

Table 2 (continued)

Category	N	%	h-index	#Citat.	Average #Citat.	Main articles
addictions (gambling, video games, screens...)						(Rhemtulla et al., 2016) [68]
Suicide and self-harm	17	4	5	175	10.3	(Baggio et al., 2018)[36] (Armour et al., 2017) [91] (Heeren et al., 2018)[36]
Eating disorders	51	12	14	503	9.8	(Levinson et al., 2017) [56] (Forbush et al., 2016) [43] (DuBois et al., 2017)[34] (Olatunji et al., 2018) [28] (van de Grift et al., 2016) [28]
Therapies	137	33	20	2104	15.3	(Borsboom, 2017) [422] (Costantini et al., 2015) [229] (Fried and Cramer, 2017)[175] (Fried et al., 2018)[113] (Isvoranu et al., 2017) [112]
Psychological variables	174	43	27	4575	26.3	(Borsboom and Cramer, 2013)[839] (Borsboom, 2017) [422] (Bringmann et al., 2013) [211] (van Borkulo et al., 2015) [200]
Methodologies	324	80	38	8276	25.5	(Borsboom and Cramer, 2013)[839] (Cramer et al., 2010)[471] (Borsboom, 2017) [422] (Borsboom et al., 2011) [239]

In addition, the most frequent standardized keywords are *methodologies* (80.60%), *mood disorders* (mostly *major depressive disorder*) (56.47%), *psychological variables* (like *self-esteem*, *emotion*, *resilience*, or *bereavement*) (43.28%), *therapies* (34.08%), and *anxiety disorders* (29.85%). It makes sense that mental disorders with the highest prevalence in the general population, such as *major depressive disorders* or *anxiety disorders*, are the ones that have attracted the most interest among researchers. This could also be explained because researchers are more likely to have access to databases with large data samples of people with depressive and anxiety disorders that can be used to analyze symptom networks. Analyses show how *mood disorders* and *anxiety disorders* are strongly related, probably because the mental health problems included in these studies share much of their symptomatology.

Furthermore, articles that use children and adolescents are strongly related to issues such as *trauma-related disorders* and *stress Factors*, *eating disorders*, *anxiety*, and *mood disorders*. Also, *affective disorders* appear to be strongly associated with other *psychological variables* (like *self-esteem*, *emotion*, *resilience*, or *bereavement*), *other disorders*, and *methodologies* for studying symptom networks.

By contrast, keywords with the least proliferation of studies on the subject are: *older adults* (1%), *suicide and self-harm* (4.23%), and *gender studies* (6.47%). According to the results, NA is applied to commonly researched areas in psychopathology. That is, the most studied areas in psychopathology are depression and anxiety (assessment, treatments, etc.), and the reason is that they are the most prevalent disorders. Furthermore, perhaps the stigma towards more vulnerable groups (women, elderly, homeless, etc.) may also be at the basis of this lack of studies prioritizing the group of adults and diagnoses of greater entities. This could also reflect the difficulty of accessing samples, or may point out the low interest of the scientific community in these topics. However, this does not diminish its importance since around 90% of people who commit suicide had some previous kind of psychological problem (Arsenault-Lapierre et al., 2004; Brådvik, 2018). Also, it is worth noting that the older population is equally affected by mental health symptomatology as the adult population. In this regard, depression and anxiety disorders are some of the most prevalent conditions among mental disorders in individuals over 65 years of age. Regarding *major depression disorders*, 11.6% of people over 65 years of age have suffered such disorder in the last year, and 17.2% from some anxiety disorder (Andreas et al., 2017). On the other hand, NA studies the gender gap again, with few studies that explicitly include gender differences, despite the importance that gender roles and social pressure to conform to them may have in the etiology, maintenance, and expression of symptoms. In addition to the fact that certain diagnoses continue to be associated with the female gender (e.g., eating, as represented in the graph), these issues may affect the implications and help-seeking (Afifi, 2007).

The analysis of symptom networks in psychopathology and mental health raises the need to pay attention to disorders not only on the basis of the DSM or ICD categories but in trying to address mental health problems from a more flexible approach that can account for the particularities of each individual, and lead to more effective interventions. However, it is worth mentioning that NA is not free of criticism, such as the debate related to replicability (Forbes et al., 2017; Borsboom et al., 2017), as well as the invariance found in networks developed by modifying certain variables (P.J. Jones et al., 2018; Schweren et al., 2018; van Loo et al. 2018). Other studies find that the network obtained, for example in depression, presents the same core symptoms as those proposed in the DSM 5 (Kendler et al., 2018), questioning the approach's contribution to the approach. This highlights the need to (i) develop more rigorous analytical methods to explore the reliability of the networks (Contreras et al., 2019), (ii) undertake studies focused on the comparison and analysis of commonalities (Dejonckheere et al., 2017), and (iii) give greater weight to the hypotheses and not so much to the exploratory analyses with little theoretical support. This highlights the need to develop more rigorous analytical methods to explore the reliability of the networks (Contreras et al., 2019), as well as to carry out studies focused on the comparison and analysis of commonalities (Dejonckheere et al., 2017), and to give greater weight to the hypotheses and not so much to the exploratory analyses with little theoretical support (Wichers et al., 2017).

Despite these NA limitations, it can be a tool with important clinical implications. Among these implications, Blanco et al. (2019) point out that network models could help clinicians analyze psychological disorders as relational patterns of patients' different events, cognitive processes and symptoms, thus opening a new field for individualized and targeted treatments of core symptoms. The challenge posed by the network model is more related to the conceptual than to the applied level (Blanco et al., 2019). Categorical diagnosis is probably necessary

for many practical reasons (Evans et al., 2013): reducing information and facilitating communication, conducting epidemiological studies or evaluating care needs, producing reports and expert opinions, making legal expert opinions, legal decisions, etc. However, it will take time to find an effective replacement that covers the many functions that these old systems have and that psychologists themselves recognize (Blanco et al., 2019).

Our study has several limitations. First, the search for studies was carried out only from the WoS database, in English, and restricted to articles published in journals, which could have limited the generalizability of the findings. Secondly, although our bibliographical search was designed to be as exhaustive as possible, it may miss some relevant articles. Third, it is necessary to take into account the limitations of the methodology used. For example, the applied bibliometric techniques do not allow a priori definition of categories or hypothesis testing, so the results should be interpreted as descriptions of the sample of articles. Fourth, the search was carried out to be as relevant as possible regarding clinical practice and psychopathology. Future research could deepen on methodological issues or, on the contrary, encompass more general matters.

Although NA has just started to be applied to psychopathology and mental health, its use has proliferated, with a wide variety of researchers, mainly from the USA and Europe, who have extensively studied symptom networks in depression, anxiety and post-traumatic stress disorders. The findings support paradigm shift claims of approaching diagnosis from a more dimensional perspective, reflecting the complex associations between symptoms. Nevertheless, despite the optimism that accompanies this methodology, the approach needs to be addressed with caution. It also has important gaps, for example, in the study of other psychological behaviors such as suicide, and populations such as the elderly and gender studies.

Data availability statement

The raw bibliographic data retrieved from WoS, the normalized database in ScimAT format is publicly available at Zenodo (<https://doi.org/10.5281/zenodo.4614134>).

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Declaration of Competing Interest

None.

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