Symptomatic networks in suicide attempt and reattempt: Relevance of psychiatric comorbidity

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Abstract

Background. One of the most relevant risk factors for suicide is the presence of previous attempts. The symptomatic profile of people who reattempt suicide deserves attention. Network analysis is a promising tool to study this field.

Objective. To analyze the symptomatic network of patients who have attempted suicide recently and compare networks of people with several attempts and people with just one at baseline.

Methods. 1043 adult participants from the Spanish cohort "SURVIVE" were part of this study. Participants were classified into two groups: single attempt group (n = 390) and reattempt group (n = 653). Different network analyses were carried out to study the relationships between suicidal ideation, behavior, psychiatric symptoms, diagnoses, childhood trauma, and impulsivity. A general network and one for each subgroup were estimated.

Results. People with several suicide attempts at baseline scored significantly higher across all clinical scales. The symptomatic networks were equivalent in both groups of patients (p > .05). Although there were no overall differences between the networks, some nodes were more relevant according to group belonging.

Conclusions. People with a history of previous attempts have greater psychiatric symptom severity but the relationships between risk factors show the same structure when compared with the single attempt group. All risk factors deserve attention regardless of the number of attempts, but assessments can be adjusted to better monitor the occurrence of reattempts.

Highlights

- People who reattempt suicide have greater severity across most clinical scales applied.
- Comorbidity and non-suicidal self-harm are central in symptomatic networks.
- The single attempt and reattempt symptomatic networks are equivalent.
- Assessments can be adjusted to better monitor the occurrence of reattempts.

Introduction

More than 720,000 people die annually by suicide around the world [1]. The WHO has urged to implement national plans to curve the increasing trends of suicide mortality observed in some countries in recent years [2-4].

Suicide includes a series of complex and fluctuating thoughts and behaviors, from passive ideas of death to suicide attempts and reattempts. Classical studies have intended to understand this phenomenon focusing on specific risk factors to detect and prevent suicide [5-7]. Some of the most studied risk factors are impulsivity, childhood trauma, depressive symptoms, or the presence of previous suicide attempts [8-13]. Specifically, the presence of previous suicide attempts is one of the most critical risk factors for reattempts. Recent work suggests that between 20 and 30% of people who attempted suicide will do so again [14,15].

Despite obtaining valuable data, this approach has proven limited. More recently, ideation-action models have gained relevance [16-19]. These models intend to study why some people transition from suicidal ideation to suicide attempts raising the polyhedric and multicausal nature of suicide. The integrated motivational-volitional model has gained the most relevance within this approach [20]. This model proposes three phases in the suicidal process: pre-motivational, motivational and volitional. At first, and through variables such as defeat and entrapment, suicidal ideation would arise. Later, through the action of certain moderators, this ideation could lead to a suicide attempt. However, many gaps remain unclear about how their interaction increases the risk of suicidal behavior [21,22].

Moving from single-factor models to the ideation-action perspective, the evolution in the field of study has come hand in hand with new statistical analysis. One of the techniques introduced with promising results is Network Analysis. Network analysis used to study mental pathology arises from Borsboom's proposal and goes beyond being a mere statistical approximation [23]. In his work, he suggested that mental pathology should be understood as a complex system, featured by the constant interaction between relevant symptoms. Recurrent interactions between symptoms can therefore be reflected by network structures. Network analysis also allows to know which symptoms are most central (more interconnected and therefore relevant) to the diagnosis studied. This way, we could better characterize the diagnoses, begin a first causal approach to the phenomena and eventually develop better treatments [24]. Furthermore, the network proposal escapes the reductionism of the traditional diagnostic vision. It defies the notion of common causes of symptoms and recognizes the relevance of feedback loops in psychopathology [25].

Although suicide is not a diagnosis, different works have tried to bring this philosophy of analysis closer to suicidal behavior [26-33]. To date, risk factors studied, populations and results present high variability [30-33]. In addition to this variability, works focused on this technique are still scarce.

Several authors raise the enormous potential of these techniques to validate complex models of suicidal behavior and to compare groups of patients by personalizing treatments [21, 27]. Comparing groups of people with a single suicide attempt versus several attempts is especially promising, and it could help detect different profiles and risk factors [34-36].

Some previous studies have approached this topic, reaching different conclusions. Nuñez et al. [30] found some differences in the networks of single-attempt and reattempt groups, although not statistically significant. De Beurs et al. [28] also found no significant differences when focusing on suicidal ideation.

To overcome some of the limitations of previous work, we searched for people who had attempted suicide recently (last 10 days). In addition, risk factors from multiple domains (motivational, volitional, cognitive, demographic, etc.) were included. Specifically, the risk factors considered were impulsivity, childhood trauma, psychiatric symptoms, previous suicidal behaviors, non-suicidal self-harm, substance use, sex, age, and acquired capability for suicide. The general symptom network was studied based on these risk factors, as well as their centrality and stability indices. Subsequently, we compared whether the network of the single attempt group and that of the reattempt group differed in their structure.

Our hypotheses are presented below. Regarding the general network, we believe that anxiety, depression, and ideation will be central nodes based on previous work [26,28,30]. Regarding differences between groups, we hypothesize that the symptom network will be more strongly connected in the reattempt group than in the single-attempt group. Borsboom [23] suggests that symptoms end up generating stability if they tend to occur together. We also believe that impulsivity will be more central in the reattempt group network [30]. Also, the variable of acquired capability will present greater centrality in the reattempt group. The acquired capability is directly related to greater pain tolerance and knowledge of suicide methods [16].

Method

Participants

For the current study, 1043 patients admitted at different hospital emergency departments due to a suicide attempt participated. The sample came from the "Suicide Prevention and Intervention Study (SURVIVE)" cohort. The SURVIVE study puts together research efforts from researchers of 10 hospitals spread across the Spanish territory. The ethical committees of all the hospitals involved approved the study. The study protocol is described in more detail elsewhere [37].

For the present work, the inclusion criteria were the following: (a) people older than 18 years, (b) attempt carried out with at least some wish to die, and (c) suicide attempt within the 10 days before the evaluation. Exclusion criteria were the following: (a) difficulties in understanding the instructions, either due to cognitive impairment or language, (b) unclear intentionality of the event, (c) medical damage after the attempt that makes it impossible to answer the questionnaires, and (d) the patient had more than 30 total lifetime attempts (considering completed, aborted and interrupted). All participants filled out the corresponding informed consent.

Data collection was performed between December 2020 and March 2023. Patient's interviews were done by specialized mental health personnel on each recruitment site.

Participants were classified into two groups according to the existence of previous suicide attempts: a reattempt group, including people who presented completed attempts prior to the index, and a single attempt group, whose index attempt was the first.

Instruments

Socio-demographics, clinical data, and characteristics of the suicidal behavior were collected using a clinical interview.

Patients were evaluated using a structured diagnostic interview. It explores the main psychiatric disorders of the DSM-5 [38]. For the analyses, the total number of diagnoses was summed. The presence of substance abuse, both alcohol and drugs, was also considered in the analysis given the relevance of these factors in previous works [36].

Psychiatric symptomatology was evaluated using the Brief Symptom Inventory (BSI) [39,40]. It is a self-administered screening scale for psychopathology. It comprises 53 items divided into different subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobia, paranoia, and psychoticism. The Cronbach's alpha reliability coefficient of the subscales in the Spanish version ranges between $.72 < \alpha < .84$. The Spanish validation study found the same nine factor structure as the original work (using confirmatory factor analysis).

Impulsivity was evaluated using the Barrat Impulsivity Scale (BIS-11) [41,42]. This is a self-administered scale of 28 questions. It allows obtaining a global impulsivity score as well as three subscales: cognitive, motor, and unplanned impulsivity. In the Spanish version, the internal consistency is around .8. The test–retest reliability after 2 months is .89. The validity parameters (factorial structure) obtained were acceptable.

Variables related to the current suicide attempt were assessed with the Columbia Suicide Rating Scale (C-SSRS) [43,44]. The C-SSRS is a clinician-administered scale that evaluates different aspects of suicidal ideation and behavior. It includes aspects such as intensity of suicidal ideation, types of suicidal behavior (completed, aborted, and interrupted attempts), and lethality of said attempts. Items referring to the severity of ideation were included in the network (most severe ideation, frequency, duration, controllability). These domains were considered because recent work points out the importance of adequately characterizing suicidal ideation and recognizing different aspects of it [45]. However, the reasons and deterrents for ideation were not considered in the network as they are eminently qualitative [44]. It also inquires about the presence of non-suicidal self-harm. The Spanish adaptation presents adequate convergent and divergent validity. In this version, Cronbach's alpha was calculated only for the ideation scale, obtaining a value of .53.

Childhood maltreatment and abuse-related information was collected by using the Childhood Trauma Questionnaire (CTQ-SF) [46,47]. This self-administered questionnaire consists of 28 items. It includes five subscales: sexual abuse, physical abuse, emotional abuse, physical neglect, and emotional neglect. The Cronbach's alpha of the subscales in the Spanish sample is between $.66 < \alpha < .94$ (the lowest being physical neglect). The Spanish adaptation showed good fit of the five-factor structure.

Acquired capability for suicide was assessed using the Acquired Capability for Suicide Scale Fearlessness About Death (ACSS-FAD) [48]. This is a 7-item self-administered scale, focused specifically on the lack of fear of death. The scale presented adequate convergent and discriminant validity.

Data analysis

First, descriptive analyses were performed. Subsequently, χ^2 tests were performed to compare qualitative variables between groups (single attempt and reattempt). Effect sizes were obtained using Cramer's *v*. For quantitative variables, Student's *t*-tests for independent samples or Mann-Whitney's *u*-tests were used (in case of highly asymmetric distributions). Hedges's *g* was used as a measure

of the effect size in the first case and Pearson's *r* in the second case. After this, the general network was estimated using all patients.

The network analysis approach was used to study the complex patterns of interactions between risk factors for suicide. Three networks were estimated: one for the complete sample, one for the single-attempt group, and one for the reattempt group. In the network, nodes represent risk factors, both demographic and clinical: age, sex, psychiatric symptomatology and diagnoses, impulsivity, suicidal ideation, childhood trauma, and acquired capability for suicide; and the edges joining the nodes represent the relationship between them once the other relationships are considered. Mixed Graphical Modeling (MGM) was used for network estimation. Networks were weighted and regularized by the Least Absolute Shrinkage and Selection Operator (LASSO).

The interpretation of networks should not be based on visual representation alone. This can lead to a misunderstanding of the relevance and relationship of the nodes. For this reason, different centrality measures are included [49]. Three centrality estimates are presented to describe the relevance of the different symptoms: strength, closeness, and betweenness. Strength expresses the sum of the edges of a given node. Closeness is a measure of the average shortest distance from nodes. Betweenness indicates the number of times a node is on the shortest path between two other nodes. A higher score in any of the three indices indicates greater centrality in the network. All measures are presented as standardized. The predictability index was also calculated. This index tells us how well we can predict a certain node based on the others. Gets values between 1 (completely determined node) and 0 (independent of the others) [50].

Finally, network robustness was tested using bootstrapping methods [51]. We will consider acceptable stability to be above .5 [51]. Each of the three networks is accompanied by its corresponding centrality and robustness values. To test for significant differences in network strength and structure between the single-attempt group and the reattempt one, we used the Network Comparison Test (NCT). It is a permutation-based hypothesis test, that can assess the difference between two networks [52]. About 1000 iterations were considered for the general comparisons. In the case of comparisons between edges, we worked with 500 iterations.

The analyses were carried out using SPSS v28.0.1.1 and R software version 4.2.2 (packages dplyr, bootnet, networktools, NetworkComparisonTest, and qgraph).

Results

Table 1 shows descriptive data on the sociodemographic and health-related variables. Data are presented for all participants (n = 1043) as well as for subgroups based on number of suicide attempts: single attempt group (n = 390) vs reattempt group (n = 653).

Differences were only found in two sociodemographic variables: marital status and employment status ($p < .01$). Regarding clinical scales, significant differences were found in all cases ($p < .01$) except in *Non-Planning Impulsivity*. The effect sizes of differences were small to medium across all factors, except for the number of suicidal behaviors being large ($p < .01$; $r = .75$) [53]. The reattempt group presented greater severity in all cases.

Table 2 shows an analysis related to suicidal ideation from the C-SSRS. In summary, significant differences were found in all cases. Greater severity was more present in the reattempt group ($p < .01$; Cramer's $v = .13$–$.23$). Effect sizes were small to moderate.

Table 1. Comparisons of sociodemographic and clinical data between the single attempt group and the reattempt group (N = 1043)

Variable	Full sample	Single attempt group (n = 390)	Reattempt group (n = 653)	χ^2/u/t	Effect size
Age	40.29(15.73)	41.43(17.25)	39.59(14.72)	−1.77	−.12
Gender					
Male	293(28.1%)	123(31.5%)	170(26%)	3.66	.06
Female	750(71.9%)	267(68.5%)	483(74%)		
Nationality					
Spanish	782(75%)	289(74.1%)	493(75.5%)	.253	.02
Other	261(25%)	101(25.9%)	160(24.5%)		
Marital status					
Single	384(36.8%)	132(33.8%)	252(38.6%)	18.17**	.13
Married	231(22.1%)	110(28.2%)	121(18.5%)		
In a relationship	191(18.3%)	68(17.4%)	123(18.8%)		
Divorced	213(20.4%)	67(17.2%)	146(22.4%)		
Widower	24(2.3%)	13(3.3%)	11(1.7%)		
Highest educational level completed					
No formal education	20(1.9%)	7(1.8%)	13(2%)	6.62	.08
Primary education	157(15.1%)	46(11.8%)	111(17%)		
Secondary education	542(52%)	203(52.1%)	339(51.9%)		
University	324(31.1%)	134(34.4%)	190(29.1%)		
Employment status					
Unemployed	286(27.6%)	89(22.8%)	197(30.4%)	19.40**	.14
Employed	423(40.8%)	189(48.5%)	234(36.1%)		
Student	138(13.3%)	49(12.6%)	89(13.7%)		
Retired	97(9.3%)	28(9.7%)	59(9.1%)		
Unable to work	94(9.1%)	25(6.4%)	69(10.6%)		
No. of suicidal behaviors	4.57(5.06)	1.54(1.11)	6.37(5.61)	15131**	.75
No. of diagnoses	4.27(2.39)	3.55(2.14)	4.70(2.44)	8.05**	.50
Substance abuse					
Yes	221(21.2%)	61(15.6%)	160(24.5%)	11.56**	.11
No	821(78.7%)	329(84.4%)	492(75.5%)		
ACSS-FAD	18.67(6.47)	17.50(6.58)	19.38(6.58)	4.56**	.29
BIS–11					
Attentional	21.19(3.75)	20.39(3.76)	21.67(3.67)	5.40**	.35
Motor	24.06(5.82)	22.62(5.48)	24.92(5.85)	6.28**	.40
Nonplanning	26.95(5.88)	26.58(5.68)	27.17(5.99)	1.57	.10
BSI					
Somatization	1.50(.98)	1.30(.97)	1.62(.97)	102045**	.16
OCD	2.19(1.05)	1.99(1.06)	2.30(1.02)	105110.5**	.14
Sensitivity	1.99(1.16)	1.75(1.14)	2.14(1.15)	102026.5**	.16
Depression	2.71(1.09)	2.45(1.16)	2.87(1.01)	99301.5**	.18
Anxiety	1.86(1.00)	1.66(.99)	1.99(0.99)	102520.5**	.16
Hostility	1.31(1.06)	1.05(.98)	1.46(1.07)	96808**	.20
Phobic	1.33(1.12)	1.12(1.05)	1.45(1.14)	104728**	.14
Paranoid	1.65(1.02)	1.45(1.02)	1.77(1.00)	103245.5**	.15
Psychoticism	1.74(.96)	1.54(.98)	1.87(.93)	101564**	.17

Continued

Table 1. *Continued*

Variable	Full sample	Single attempt group (n = 390)	Reattempt group (n = 653)	χ²/u/t	Effect size
CTQ-SF					
Emotional abuse	13.27(6.62)	11.63(6.11)	14.27(6.72)	98421**	.19
Physical abuse	9.58(5.90)	8.24(5.11)	10.41(6.21)	99995.5**	.19
Sexual abuse	9.46(6.71)	7.86(5.38)	10.43(7.24)	102269.5**	.18
Emotional negligence	13.28(5.69)	12.36(5.61)	13.86(5.67)	107744**	.13
Physical negligence	8.58(3.95)	8.13(3.66)	8.86(4.09)	114123**	.09
Non-suicidal self-harm					
Yes	440(42.2%)	115(29.5%)	325(49.8%)	41.19**	.20
No	603(57.8%)	275(70.95%)	328(50.2%)		

Note: Scores are presented as mean (standard deviation) for continuous variables and number (percentage) for categorical ones. χ^2 is presented for categorical variables; u is presented for number of suicidal behaviors, BSI sub scores and CTQ-SF sub scores. t is presented in the rest of the variables. (*) statistically significant differences at $p < .05$. (**) statistically significant differences at $p < .01$.
ACSS-FAD, Acquired Capability for Suicide Scale Fearlessness About Death; BIS-11, Barratt impulsivity scale; BSI, Brief symptoms inventory; CTQ-SF, Childhood Trauma Questionnaire- short form. Gender was categorized as 0 = female and 1 = male. Nº of suicidal behaviors accounts for all attempts, whether completed or otherwise.

Table 2. Comparisons of C-SSRS ideation scores between the single attempt and reattempt groups

Variable	Full sample	Single attempt group (n = 390)	Reattempt group (n = 653)	χ²	Effect size
Most severe ideation					
No ideation	107(10.3%)	50(12.8%)	57(8.7%)	53.81**	.23
Wish to be dead	54(5.2%)	35(9%)	19(2.9%)		
Nonspecific active suicidal thoughts	102(9.8%)	57(14.6%)	45(6.9%)		
Active ideation without intent	205(19.7%)	76(19.5%)	129(19.8%)		
Active ideation with intent, no plan	240(23%)	83(21.3%)	157(24%)		
Active ideation with plan and intent	335(32.1%)	89(22.8%)	246(37.7%)		
Frequency					
No ideation	107(10.3%)	50(12.8%)	57(8.7%)	42.85**	.20
Less than once a week	194(18.6%)	103(26.4%)	91(13.9%)		
Once a week	58(5.6%)	23(5.9%)	35(5.4%)		
2–5 times	204(19.6%)	72(18.5%)	132(20.2%)		
Daily	249(23.9%)	86(22.1%)	163(25%)		
Many times, each day	231(22.1%)	56(14.4%)	175(26.8%)		
Duration					
No ideation	107(10.3%)	50(12.8%)	57(8.7%)	28.61**	.17
Fleeting	203(19.5%)	97(24.9%)	106(16.2%)		
Less than 1 hour/some of the time	209(20%)	85(21.8%)	124(19%)		
1–4 hours/a lot of time	217(20.8%)	71(18.2%)	146(22.4%)		
4–8 hours/most of the day	123(11.8%)	40(10.3%)	83(12.7%)		
More than 8 hours/persistent	184(17.6%)	47(12.1%)	137(21%)		
Controllability of suicidal thoughts					
Not attempt	254(24.4%)	110(28.2%)	144(22.1%)	21.81**	.15
Easily	89(8.5%)	43(11%)	46(7%)		
Little difficulty	73(7%)	34(8.7%)	39(6%)		
Some difficulty	185(17.7%)	71(18.2%)	114(17.5%)		
Lot of difficulty	202(19.4%)	59(15.1%)	143(21.9%)		
Unable	240(23%)	73(18.7%)	167(25.6%)		

Continued

Table 2. *Continued*

Variable	Full sample	Single attempt group (n = 390)	Reattempt group (n = 653)	χ^2	Effect size
Deterrents					
Definitely stopped you	215(20.6%)	93(23.8%)	122(18.7%)	23.27**	.15
Probably stopped you	161(15.4%)	54(13.8%)	107(16.4%)		
Uncertain	85(8.1%)	29(7.4%)	56(8.6%)		
Most likely did not stop you	77(7.4%)	22(5.6%)	55(8.4%)		
Definitely did not stop you	362(34.7%)	118(30.3%)	244(37.4%)		
Does not apply	143(13.7%)	74(19%)	69(10.6%)		
Reasons					
Completely to get attention	10(1%)	1(.3%)	9(1.4%)	17.83**	.13
Mostly to get attention	14(1.3%)	8(2.1%)	6(.9%)		
Equally to get attention and to end the pain	81(7.8%)	30(7.7%)	51(7.8%)		
Mostly to end the pain	202(19.4%)	75(19.2%)	127(19.4%)		
Completely to end the pain	602(57.7%)	208(53.3%)	394(60.3%)		
Does not apply	134(12.8%)	68(17.4%)	66(10.1%)		

Note: Scores are presented as number (percentage) for categorical ones (*) statistically significant differences at p < .05. (**) statistically significant differences at p < .01.
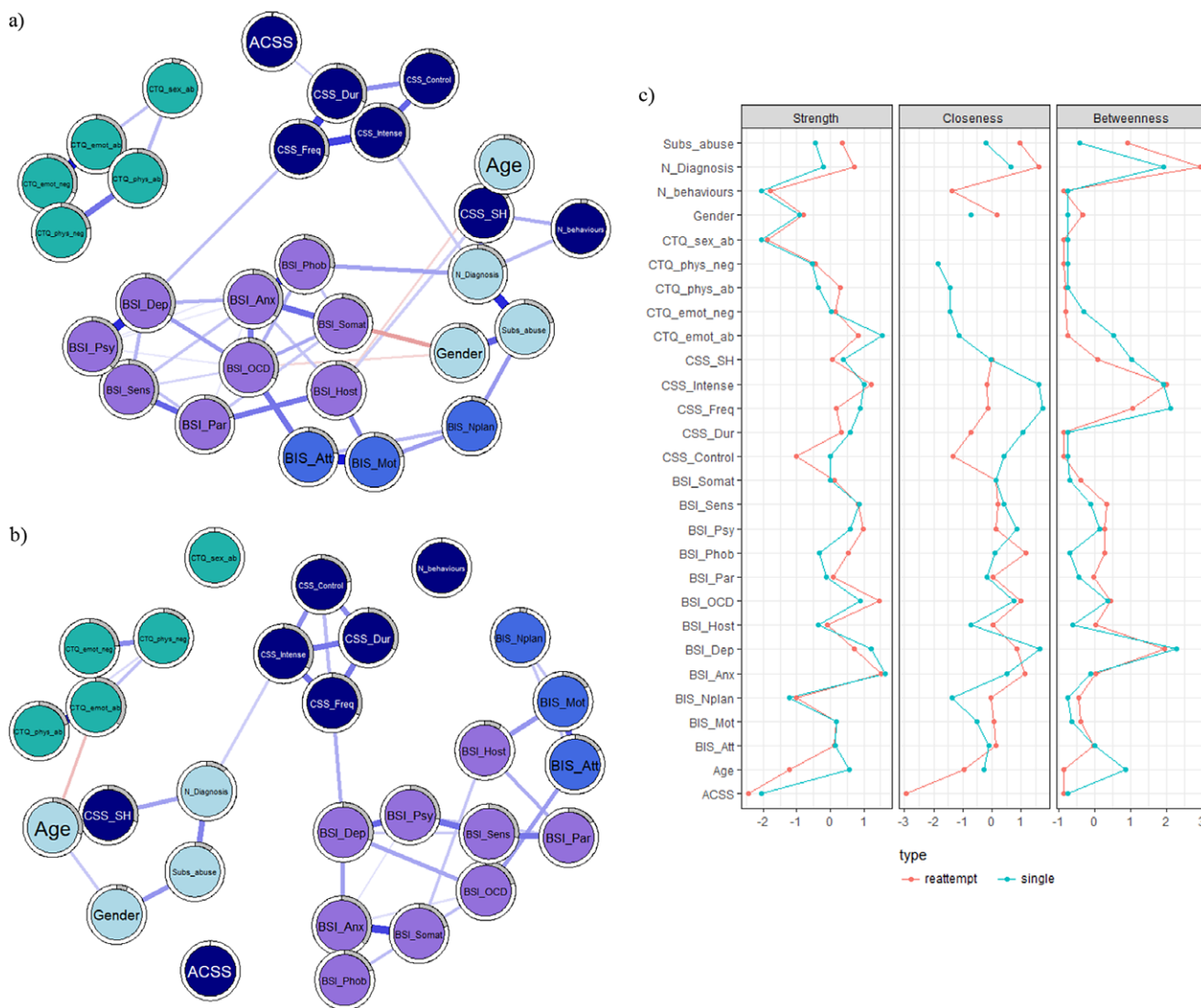
The symptomatic network of the entire sample can be seen in Figure 1(a). The centrality indices are presented below (Figure 1(b)). Considering strength, the most relevant nodes were the number of diagnoses as well as anxious symptoms and emotional abuse (followed by interpersonal sensitivity and psychotic symptoms). Closeness and betweenness pointed out the relevance of diagnoses, in addition to non-suicidal self-harm. The network had adequate edge stability (CS = .75) and strength values (CS = .67). The exact predictability values can be seen in Table S1 of the Supplementary Materials. They range between 0 (for the ACSS) and .41 (psychotic symptoms).

The reattempt group network (n = 653) (Figure 2(a)) showed a similar configuration to that of the global network. The nodes with the highest strength were anxious and obsessive-compulsive
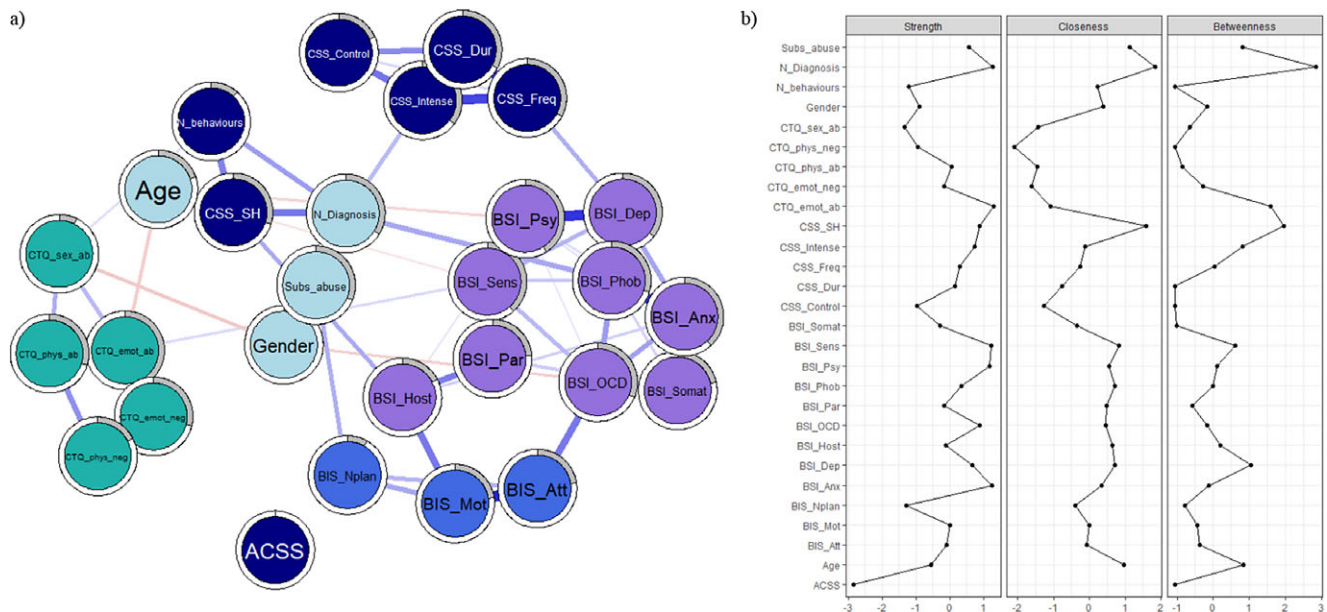
Figure 1. (a) Network displaying the relationship between Symptoms in the full sample. (b) Centrality indices of Symptoms. Edges in blue indicate positive relationship. Edges in red indicate negative relationship. Thicker edges represent stronger associations. The colors of the nodes group the scores of the CTQ, the BIS, the BSI, suicide-related behaviors, and other covariates. The gray border on the nodes reflects predictability. Subs_abuse = Does the patient have substance abuse; N_Diagnosis = number of diagnoses; N_behaviors = Total number of suicidal behaviors (completed, interrupted, and aborted attempts). CTQ (Childhood trauma Questionnaire): sex_ab = sexual abuse; phys_neg = physical negligence; phys_ab = physical abuse; emot_neg = emotional negligence; emot_ab = emotional abuse. CSS (Columbia suicide severity rating scale): SH = self-harm; Intense = most intense ideation; Freq = ideation frequency; Dur = Duration of ideation; Control = controllability of suicidal thoughts. BSI (Brief Symptoms Inventory): Somat = somatization; Sens = interpersonal sensitivity; Psy = psychoticism; Phob = phobias; Par = paranoia; OCD = obsessive-compulsive; Host = hostility; Dep = depression; Anx = anxiety. BIS (Barratt impulsivity scale): Nplan = unplanned impulsivity; Mot = motor impulsivity; Att = attentional impulsivity. ACSS (Acquired Capability for Suicide Scale Fearlessness About Death).

Figure 2. (a) Network displaying the relationship between symptoms in the reattempt group. (b) Network displaying the relationship between symptoms in the single attempt group. (c) Centrality indices of Symptoms. Edges in blue indicate positive relationship. Edges in red indicate negative relationship. Thicker edges represent stronger associations. The colors of the nodes group the scores of the CTQ, the BIS, the BSI, suicide-related behaviors and other covariates. The gray border on the nodes reflects predictability. Subs_abuse = Does the patient have substance abuse; N_Diagnosis = number of diagnoses; N_behaviors = Total number of suicidal behaviors (completed, interrupted, and aborted attempts). CTQ (Childhood trauma Questionnaire): sex_ab = sexual abuse; phys_neg = physical negligence; phys_ab = physical abuse; emot_neg = emotional negligence; emot_ab = emotional abuse. CSS (Columbia suicide severity rating scale): SH = self-harm; Intense = most intense ideation; Freq = ideation frequency; Dur = Duration of ideation; Control = controllability of suicidal thoughts. BSI (Brief Symptoms Inventory): Somat = somatization; Sens = interpersonal sensitivity; Psy = psychoticism; Phob = phobias; Par = paranoia; OCD = obsessive-compulsive; Host = hostility; Dep = depression; Anx = anxiety. BIS (Barratt impulsivity scale): Nplan = unplanned impulsivity; Mot = motor impulsivity; Att = attentional impulsivity. ACSS = Acquired Capability for Suicide Scale Fearlessness About Death.

symptoms. The closeness measure shows the relevance of the number of diagnoses, anxiety, and phobic symptoms. Betweenness presented as relevant to the number of diagnoses, intensity of ideation, and depressive symptoms. The network presented an edge stability coefficient of .75 and a strength coefficient of .59, both being adequate. Predictability ranged from .1 (for the ACSS) to .38 (for psychotic symptoms).

Finally, the network of people with one attempt (n = 390) (Figure 2(b)) showed some differences in its centrality indices. Based on strength, the most central nodes were emotional abuse and anxious symptoms. Regarding closeness, intensity and frequency of ideation as well as depressive symptoms were the most relevant nodes. Looking at betweenness, intensity of ideation, depressive symptoms, and number of diagnoses were the most

relevant nodes. This network also had adequate edge stability (CS = .75) and strength indices (CS = .59). Predictability ranged from .0 (for the ACSS and the number of behaviors) to .36 (anxious symptoms and emotional abuse).

In all networks, subscales belonging to the same constructs tended to be interconnected. The symptoms presented greater density in their connections in the global network and in the reattempt group. In general terms, the trauma and acquired capability scores were quite separated from the rest.

Regarding the comparison between the networks, the network invariance test was not significant (p = .88). The global strength invariance test did not find significant differences (p = .34). Therefore, no differences were found between the networks in either structure or strength. Although no differences were found between

both networks in global terms, differences between specific edges were studied. The edges between the following variables differed depending on the group: gender and age; age and emotional abuse; somatic and anxiety symptoms; emotional abuse and physical neglect; hostility and somatic symptoms; gender and obsessive symptoms; physical abuse and physical neglect and finally, frequency and control of ideation (*p* ranging from .001 to .049). The differences should not be overinterpreted, given the high number of comparisons made.

Figures S1, S3, and S5 (see Supplementary Material) show the bootstrapped confidence intervals of the edge weights for each of the networks. Some confidence intervals are considerably wide (even overlapping), so it would be advisable to interpret the order of the edges carefully. Figures S2, S4, and S6 (see Supplementary Material) show the average correlations of strength measure sampled with persons dropped and the original sample. They show generally good stability of node strength.

Discussion

The present work has applied the perspective of symptomatic networks to study a wide range of risk factors relevant to suicidal behavior. Previous work has already applied this analysis to suicide outcomes, but always focused on a smaller number of risk factors [27–30,32,33]. In addition, our study included a wide sample of the Spanish population with a recent attempt. The aim was to improve the understanding of the complex relationships between risk factors in this group of patients. Also, we sought to compare networks between people with a single suicide attempt versus several attempts.

People with more than one suicide attempt have greater severity across most clinical scales applied. Our hypotheses about the general network have been partially fulfilled. Although anxiety and depression are relevant nodes, in the present work, the most central node is the number of diagnoses, according to several indices. We could understand this as an indicator of greater severity, and it has already been addressed in previous works related to suicide risk [54,55]. The other most relevant nodes were non-suicidal self-harm, anxious symptoms, and emotional abuse. These results are in line with what was found by a recent meta-analysis [15]. The presence of non-suicidal self-harm has been postulated as a relevant risk factor, among other things, because it is understood as a way of losing the fear of pain and death [56]. Besides, the presence of non-suicidal self-harm is a way of regulating a deep discomfort that may have to do with psychiatric comorbidity, impulsivity, and a history of trauma in patients with multiple attempts [57]. Both anxious symptoms and emotional abuse have also demonstrated their relevance previously [15, 58].

Regarding subgroups' networks, differences were expected between people with a single attempt and several attempts. The reattempt group network presents some equivalent indices to the global one, but obsessive-compulsive, phobic symptoms and intensity of ideation also appear relevant. More symptomatic nodes are central, which could once again indicate the relevance of comorbidity. The single-attempt group network showed some differences in terms of centrality indices, with ideation being more central (according to closeness and betweenness). This may be consistent with the ideation-to-action models as people could have made the transition from ideation for the first time [17]. Additionally, the reattempt group's network seems more interconnected. However, the networks were not significantly different either in their structure or in their overall strength. This finding is consistent with previous work [28,30]. Both argued that the lack of differences

could be because the entire sample has already attempted suicide, which could limit the variability of the results. In our work, the single attempt sample was relatively smaller and could affect the variability of the results. The integrated motivational volitional model does not propose a difference between variables in the repetition of the suicide attempt but rather a faster transition between phases [20].

Given the importance of the number of diagnoses in the network, and the differences in all scales, it could be argued that people with one or several attempts differ mainly in the severity of pathology. Their networks are not related to different intensities or structures, but the symptoms are more serious in the case of people who make several attempts. Similar data has been found in some previous works [15,34,36].

Results related to the ACSS-FAD test were unexpected. O'Connor's model raises its relevance in the transition from ideation to suicide attempt [19]. However, it has turned out to be the least central node in all the networks. This goes against our initial hypotheses. However, the presence of non-suicidal self-harm has been relevant [56].

With respect to predictability, it is observable that the values are moderate-low in most cases. That is, each node is not very predictable based on others. This is especially relevant in the case of the ACSS-FAD.

The study has several limitations, which are discussed below. Data comes from a cross-sectional design preventing the establishment of causal relationships. Network analysis does not provide information on directionality or causality. However, it allows for the conceptualization of complex interrelationships between symptoms and psychosocial components.

There are differences in some clinical and demographic measures between recruiting centers. This is something to be expected given that a representative sample of the Spanish population is sought, and each region presents different socioeconomic characteristics. Also, the proposed networks are not culturally independent and must be understood contextually to their time and space [25].

All measures were self-reported, and some of them resulted in scores of several symptoms collapsed into a single measure, which could reduce variability [30]. For the analyses, only data from participants who completed all the scales were considered; this could lead to a certain degree of self-selection in the sample, limiting generalizability.

Furthermore, we have focused our work on different variables that have been relevant in past studies (specifically, impulsivity, childhood trauma, suicidal ideation, and psychiatric symptoms). There are other relevant variables not considered that could also be relevant, thus conclusions must be limited to the variables considered.

Despite limitations, different relevant aspects can be extracted. Network analysis represents a novel and scarcely used way of approaching the suicidal phenomenon. This is an interesting approach given the multicausality and complexity of suicide [21]. It is proposed that this may be useful for clinicians, focusing treatments on the most relevant nodes of the network [24].

People with several suicide attempts present more severe symptoms than people with just one. Symptom networks are not significantly different between both groups, but some nodes and edges differed in each case. The lack of differences in networks could indicate that it is necessary to thoroughly evaluate risk factors regardless of the number of previous attempts. However, differences at the node centrality in each network suggest that assessments can be adjusted to better monitor the occurrence of reattempts.

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