



Research paper

Directionality of change in obsessive compulsive disorder (OCD) and suicidal ideation over six years in a naturalistic clinical sample[☆]



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ABSTRACT

Background: Obsessive compulsive disorder (OCD) is associated with elevated suicide risk, but the directionality of the association between OCD severity and suicidal ideation has not been established, which was the goal of this study.

Methods: Participants ($n = 325$) were adults with either a current or past diagnosis of Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) OCD who were assessed annually for suicidal ideation and OCD symptom severity for six years. Cross-lagged panel analyses statistically compared unidirectional and bi-directional models over time. Serious suicide-related adverse events were reported.

Results: The best-fitting and most parsimonious model included paths predicting suicidal ideation from OCD symptom severity, but not vice versa. These results were confirmed by comparing a model with cross-lagged paths constrained equal to a freely estimated model. Higher OCD symptom severity in a given year was associated with a higher suicidal ideation severity in the subsequent year. Five suicide-related adverse events were reported throughout the duration of the study, including two suicide deaths and three suicide attempts.

Limitations: The study relied on a single-item, annual measure of suicidal ideation in adults, with substantial variability in severity of suicide risk, and missing data increased with later observations in the study.

Discussion: OCD symptom severity predicted next year suicidal ideation severity. In contrast, suicidal ideation severity in a given year did not predict next-year OCD symptom severity in this OCD sample. Thus, rather than waiting for suicidal ideation to resolve, clinicians should consider providing empirically supported treatments for OCD.

Introduction

Obsessive compulsive disorder (OCD) is characterized by obsessions, or intrusive, unwanted thoughts, images, and rituals to neutralize related distress (American Psychiatric Association, 2013). Approximately 2% of the population is affected by this disorder (Ruscio et al., 2010). There are numerous negative consequences of OCD, including reduced quality of life (Ruscio et al., 2010) and high rates of other psychiatric comorbidities (Hofer et al., 2018; Nordhal et al., 2018; Toftdahl et al., 2016).

While the consequences of OCD have been well-characterized, the

association between OCD and suicide has only been established relatively recently. Many reports described ego-dystonic thoughts of suicide as one common obsession content area (Rachamalla et al., 2017; Wetzler et al., 2007), though only a few have explored ego-syntonic thoughts of suicide (Chaudhary et al., 2016). This is a critical area for clarification because suicide rates have steadily increased in the past decade (Centers for Disease Control and Prevention, 2014). On the one hand, some large-scale studies have found that whereas certain anxiety-related disorders were associated with suicide risk (namely posttraumatic stress disorder (PTSD), panic disorder, social anxiety disorder and generalized anxiety disorder), OCD was not (Bentley et al., 2016;

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Kanwar et al., 2013; Simon et al., 2007). However, one of these studies had a small sample of participants with OCD, which may have limited the power to detect an association with suicide (Bentley et al., 2015). On the other hand, several OCD cohort studies found a correlation between OCD and suicide risk (Brakoulias et al., 2017; Ching et al., 2017; Chaudhury et al., 2016; Velloso et al., 2016; for a meta-analysis, see Angelakis et al., 2015; Dell'Osso, Casu, Carlini, Conversano, Gremini & Carmassi, 2012; Torres et al., 2011; Fernández de la Cruz et al., 2017; Harris & Barraclough, 1997). These studies have reported that patients with OCD have 3–5 times the risk of attempting suicide (Fernández de la Cruz et al., 2017; Hollander et al., 1996) and 3–10 times the risk of dying by suicide compared to healthy comparisons (Fernández de la Cruz et al., 2017; Harris & Barraclough, 1997; Meier et al., 2016).

The methodology of prior studies may account for the inconsistency of these findings. Several prior studies relied on cross-sectional designs, which prevent an understanding of the intricacies of an association over time, and many of the non-significant effects emerged in non-OCD cohort studies. A recent meta-analysis (Angelakis et al., 2015) increased clarity on the association between OCD and suicide and found a significant association between OCD and suicidality broadly defined, but with substantial heterogeneity across studies.

Despite the recent evidence supporting a positive association between OCD and suicide, the directionality of this association has not been reported. Greater severity of OCD symptoms at a given time-point may predict suicide risk at a subsequent time-point; however, it is equally plausible that in a cohort sample of patients with OCD, suicide risk at a given time-point may predict subsequent OCD severity. Determining the direction of the association between OCD and suicide risk is critical both for understanding the course of the illness and for informing intervention development and delivery. For instance, clinicians do not implement exposure therapy, a preferred treatment for OCD, due to concerns about the risk for decompensation (Meyer et al., 2014; Hofmann et al., 2012). If OCD symptoms predict suicide risk to a greater extent than the converse, then clinicians should immediately provide evidence-based treatments for OCD rather than wait until suicide risk remits. Conversely, if suicide risk predicts future OCD symptoms, then clinicians should deliver an intervention that targets suicide risk directly and perhaps, in some cases, exclusively. If there is a bidirectional relationship between suicide risk and OCD symptoms, then clinicians are further justified in integrating OCD treatments with suicide-focused interventions in to maximize outcome, rather than waiting for suicidal ideation to remit prior to initiating OCD treatment.

The current study aimed to determine the directionality between OCD and suicidal ideation in a longitudinal study of adults assessed annually over 6 years through the Brown Longitudinal Obsessive-Compulsive Study (BLOCS; Pinto et al., 2006). We hypothesized that reductions in OCD over time would be associated with reductions in suicide over time. However, our investigation of the influence of suicidal ideation over time on OCD symptoms over time was exploratory in nature as, to our knowledge, there are no prior studies addressing this research question.

2. Methods

2.1. Participants

Participants ($n = 325$) were adults enrolled in a large naturalistic prospective study to observe the course of OCD. The primary outcomes and procedures of this study have been previously published (Pinto et al., 2006; Eisen et al., 2010, 2013; Mancebo et al., 2006). In brief, inclusion criteria were a current or past primary diagnosis of OCD based on *Diagnostic and Statistical Manual for Mental Disorders 4th Edition, Text Revision* (American Psychiatric Association, 2013) criteria, and having sought treatment within the five years prior to study entry. Of the full sample, 82% had a current episode of OCD at the intake assessment,

Table 1
Sample Demographics.

Variable	Value
Gender, n (%)	
Female	177 (54.5)
Male	148 (45.5)
Race, n (%)	
Asian	3 (0.9)
Black or African American	3 (0.9)
White	317 (97.5)
More than one race	1 (0.3)
Unknown	1 (0.3)
Ethnicity, n (%)	
Hispanic or Latino	8 (2.5)
Not Hispanic or Latino	316 (97.2)
Unknown	1 (0.3)
Age at intake, mean (SD)	40.12 (12.79)
Employed at intake, n (%)	189 (58.2)
Education level at intake, n (%)	
High school graduate, GED or part high school	73 (22.2)
College degree or part college	186 (57.2)
Graduate degree or part graduate school	67 (20.6)
Most distressing obsession	
Aggressive	41 (12.6)
Responsibility	53 (16.3)
Contamination	58 (17.8)
Sexual	22 (6.8)
Hoarding	23 (7.1)
Religious	18 (5.5)
Symmetry	40 (12.3)
Somatic	27 (8.3)
Missing	18 (5.5)
Miscellaneous	25 (7.7)
Most distressing compulsion	
Washing/Cleaning	43 (13.2)
Checking	80 (24.6)
Repeating	30 (9.2)
Counting	25 (7.7)
Ordering/arranging	10 (3.1)
Hoarding	23 (7.1)
Miscellaneous	94 (28.9)
Missing	20 (6.2)
Past month diagnosis (at intake)	
Anxiety disorder (not OCD)	138 (42.5)
Mood disorder	60 (18.5)
Major depressive disorder	53 (16.3)
Substance use disorder	17 (5.2)
Eating disorder	6 (1.8)
Psychotic disorder	5 (1.5)

and 92% had a score of 8 or higher (indicative of at least mild symptoms) on the Yale-Brown Obsessive Compulsive Scale (YBOCS; Goodman et al., 1989b). The only exclusion criterion was evidence of an organic mental disorder or other condition that would prevent participants from providing informed consent. See Table 1 for sample demographics.

2.2. Measures

Suicidal Ideation. The presence of suicidal ideation was measured using the suicidal ideation item of the Modified Hamilton Rating Scale for Depression (MHRSD). This 25-item rater-administered interview assesses symptoms of depression in the past week and has strong reliability and validity (Miller et al., 1985). The suicidal ideation item (MHRSD_{SI}) is rated on the following scale: 0 = absent, 1 = feels life is not worth living, 2 = wishes s/he were dead or any thoughts of possible death to self, 3 = suicidal ideas or gesture, 4 = attempts at suicide (see Table 2 for sample means).

OCD. Severity of OCD was measured using the Yale-Brown Obsessive Compulsive Scale (YBOCS; Goodman et al., 1989b), a 10-item rater administered interview with good reliability and validity (Goodman et al., 1989a, 1989b). The scale contains five items that

Table 2

Frequencies and Means of Modified Hamilton Rating Scale for Depression Suicide Item (MHRSD_{SI}) Endorsement and Yale Brown Obsessive Compulsive Scale (YBOCS) Total Score.

MHRSD _{SI} Score	Month 0 n(%)	Month 12 n(%)	Month 24 n(%)	Month 36 n(%)	Month 48 n(%)	Month 60 n(%)	Month 72 n(%)
0	273 (85.6)	231 (86.5)	193 (88.1)	165 (88.2)	122 (89.1)	121 (90.3)	93 (90.3)
1	22 (6.9)	26 (9.7)	19 (8.7)	15 (8.0)	9 (6.6)	4 (3.0)	6 (5.8)
2	16 (5.0)	7 (2.6)	7 (3.2)	7 (3.7)	6 (4.4)	8 (6.0)	1 (1.0)
3	8 (2.5)	3 (1.1)	0 (0)	0 (0)	0 (0)	1 (0.8)	3 (2.9)
	mean: 0.24, SD: 0.66	mean: 0.18, SD: 0.52	mean: 0.15, SD: 0.44	mean: 0.16, SD: 0.45	mean: 0.15, SD: 0.47	mean: 0.17, SD: 0.56	mean: 0.17, SD: 0.58
YBOCS	Month 0 (mean, SD) 20.60 (8.43)	Month 12 (mean, SD) 17.40 (8.95)	Month 24 (mean, SD) 17.14 (9.14)	Month 36 (mean, SD) 17.15 (9.36)	Month 48 (mean, SD) 16.54 (9.74)	Month 60 (mean, SD) 17.34 (9.90)	Month 72 (mean, SD) 17.54 (10.30)

Table 1 Note. Frequencies and means were calculated for a variable assuming no missing data on the other variable at a given observation.

assess the severity of compulsions and five that assess the severity of obsessions in the past week. Total scores range from 0–40 with higher scores indicating greater symptom severity.

2.3. Procedure

The study was approved by the institutional review board (IRB) of Butler Hospital and Brown University. Participants were recruited between 2001 and 2006 from several psychiatric facilities (i.e. outpatient clinics, inpatient units, private practices, and community mental health centers) and were assessed yearly thereafter. The annual interviews were conducted in person or via phone by trained research assistants. All interviewers had at least a bachelor's degree and were trained to reliability, including attending training sessions, viewing and rating sample tapes, and correcting discrepancies between raters. Detailed description of rater training procedures including procedures for maintaining interrater reliability are reported elsewhere (Pinto et al., 2006). Every effort was made to conduct the interview in person, including conducting the interviews at a participant's home or providing travel vouchers to facilitate an in-person interview. Only when these efforts did not allow for an in-person evaluation (i.e., the person moved out of the area) were interviews conducted over the phone. Serious adverse events, including suicidal behavior, were identified during follow-up evaluations and were reported to the IRB within 24 h.

2.4. Data analysis

Cross-lagged panel analyses were conducted following procedures outlined in prior research (Martens & Hasse, 2006) in MPlus (Muthén & Muthén, 2012) to compare the association between suicide (MHRSD_{SI}) and OCD (YBOCS total score). This procedure involves four iterations of model-testing to determine the directionality.

Model 1, the autoregressive model, only accounted for the change over time *within* each measure (Fig. 1 Paths “A”). Specifically, MHRSD_{SI} at baseline was entered as a predictor of MHRSD_{SI} at month 12, and MHRSD_{SI} at month 12 was entered as a predictor of MHRSD_{SI} at month 24, and so on. Importantly, model fit was improved by adding predictive paths from the baseline observation of each variable to each subsequent observation of the variable.¹ The autoregressive model included the same YBOCS paths, with baseline YBOCS entered as a predictor of YBOCS at month 12, and so on. In addition, we correlated the baseline MHRSD_{SI} and YBOCS scores, as well as the errors of each subsequent observation across the MHRSD_{SI} and YBOCS.

¹ Model fit was further improved by adding the following parameters, per modification index recommendations: MHRSD_{SI} at month 24 to MHRSD_{SI} at month 48, MHRSD_{SI} at month 36 to MHRSD_{SI} at month 60. These are not documented in Figs. 1 or 2 for easier visualization. These paths were added prior to the addition of any cross-lagged paths to prevent an influence on the directionality of results. Furthermore, no cross-lagged paths were added on the basis of modification indices.

Model 2 included the paths specified from Model 1 plus paths from MHRSD_{SI} at a given observation to YBOCS at the subsequent observation (Fig. 1 Paths “B”). Model 3 included the paths specified from Model 1 as well as paths from YBOCS at a given observation to MHRSD_{SI} at the subsequent observation (Fig. 1 Paths “C”). Model 4 included all the paths specified in Models 1–3.

Comparison between Models 1 and 2 allows for a determination of improvement in autoregressive model fit after accounting for prediction of OCD severity from suicidal ideation (“B”). Comparison between Models 1 and 3 allows for a determination of improvement in autoregressive model fit after adding paths predicting suicidal ideation from OCD (“C”). Comparison between Models 2 and Model 4 allows for a determination of the importance of paths that are left out of Model 2 (“C”) to determine the relative importance of these paths compared to the full model (including “A”, “B” and “C”). Comparison between Models 3 and 4 allows for a determination of the importance of paths that are left out of Model 3 (“B”) to determine the relative importance of these paths compared to the full model (“A”, “B”, and “C”).

Due to increasing missing data beyond 72 months (32% of data available at 72 months versus 28.5% of data available at 84 months and 19% available at 96 months, relative to baseline), only observations until this point were included. Models were unable to converge with the inclusion of observations beyond this point because of covariance coverage challenges due to missing values.

3. Results

The autoregressive model (Model 1) was significantly improved with the addition of paths from YBOCS to MHRSD_{SI} (Model 3, see Table 3 Column 2, Row 3), but not from MHRSD_{SI} to YBOCS (Model 2, Table 3, Column 2, Row 4). The full model significantly improved model fit compared to Models 1, 2 and 3 (Table 3, Column, Rows 3 and 4). However, because Model 2 did not outperform Model 1, Model 3 was the best fitting model.

In terms of individual parameters for Model 3, YBOCS predicted MHRSD_{SI} from baseline to year 1 and from 36 to 48 months. In both cases, higher YBOCS severity in a given year was associated with a higher MHRSD_{SI} severity in the subsequent year.

In Model 3, there was generally greater stability in the within-variable predictive paths from one year to the next in terms of YBOCS scores, which had significant autoregressive paths at all points, compared to MHRSD_{SI} scores, which had two non-significant autoregressive paths. To be conservative in ensuring that paths from MHRSD_{SI} to YBOCS were unnecessary, a bidirectional model (i.e., Model 4) was run with a test of model constraints, wherein paths from MHRSD_{SI} to YBOCS were constrained to be equal to paths from YBOCS to MHRSD_{SI}. This Wald test of parameter constraints confirmed that when the bidirectional paths were constrained to be equal, model fit was significantly worsened (Wald Test Value: 126.899 (*df* = 6), *p* < .001). This suggests that the path strength was not statistically equivalent, providing further evidence that Model 3, which excluded the paths

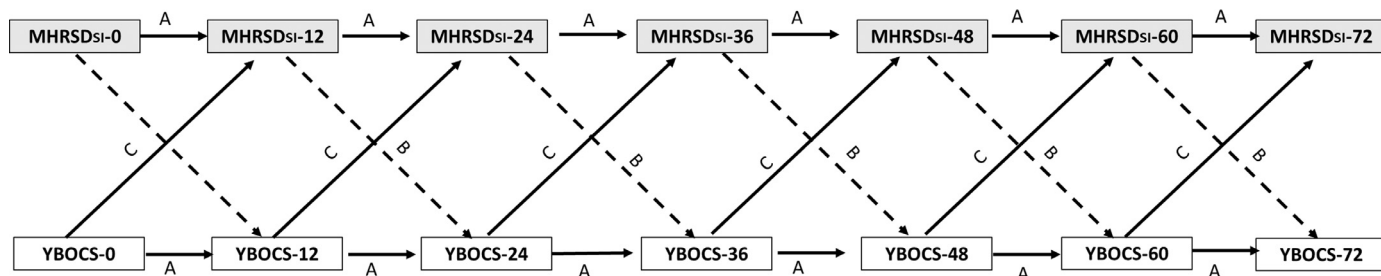


Fig. 1. Model of Change over Time in Modified Hamilton Rating Scale for Depression Suicide Item (MHRSD_{SI}) and in the Yale Brown Obsessive Compulsive Scale (YBOCS).

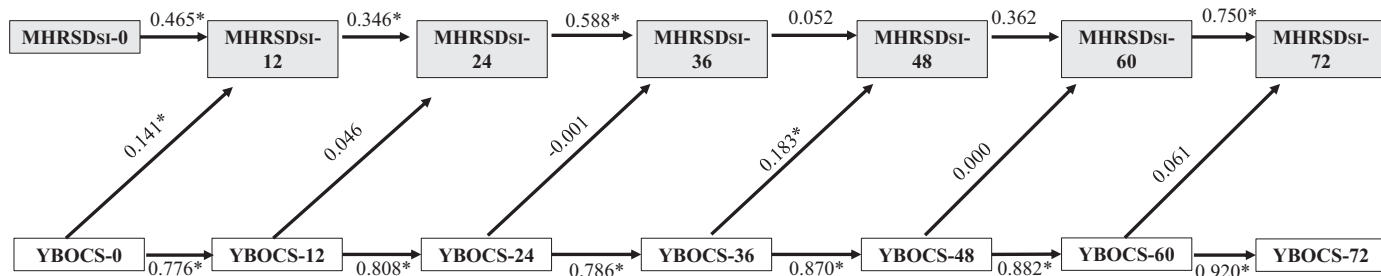


Fig. 2. Standardized Beta Scores in Model 3, Reflecting Change over Time in Modified Hamilton Rating Scale for Depression Suicide Item (MHRSD_{SI}) and in the Yale Brown Obsessive Compulsive Scale (YBOCS).

Table 3
Model Comparison and Fit.

	χ^2	df	Correction Factor	Difference from Model 1	Difference from Model 4	AIC	BIC	CFI	RMSEA	SRMR
Model 1: Auto-regressive model	113.157	60	1.0956	–	38.63 ($p < .001$)	10,859.77	11,083.03	.956	.052	.090
Model 2: MHRSD _{SI} → YBOCS	104.031	54	1.1087	8.833 ($p = .183$)	46.87 ($p < .001$)	10,863.15	11,109.09	.958	.053	.067
Model 3: YBOCS → MHRSD _{SI}	95.408	54	1.1313	20.72 ($p = .002$)	17.431 ($p = .008$)	10,855.73	11,101.68	.965	.049	.051
Model 4: Full Model	81.535	48	1.2008	38.63 ($p < .001$)	–	11,753.57	12,034.99	.970	.042	.039

Note: AIC, Akaike's Information Criterion, BIC, Bayesian Information Criterion, CFI, Comparative Fit Index, df, Degrees of Freedom, RMSEA, Root Mean Squared Error of Approximation, SRMR, Standardized Root Mean Square Residual.

from MHRSD_{SI} to YBOCS, was the best fitting model. Furthermore, examination of the parameter strength from Model 4 revealed that for all but two of the bidirectional paths, parameters were greater for the path predicting MHRSD_{SI} from YBOCS compared to the opposite.

Five suicide-related adverse events were reported throughout the duration of the study, including two suicide deaths and three suicide attempts.

4. Discussion

A unidirectional relationship was observed between OCD symptoms and suicidal ideation, with more severe OCD symptoms predicting more severe suicidal ideation in the following year. These findings are consistent with a recent meta-analysis in which OCD was associated with heightened suicide risk (Angelakis et al., 2015). While there is a well-established literature base documenting the association among suicide and other anxiety-related disorders (Brown et al., 2010, 2016; Simon et al., 2007), a burgeoning evidence-base documents the association between OCD and suicide risk. This is the first study of its kind to inform a directional relationship wherein OCD symptoms predict subsequent suicidal ideation. Suicidal thoughts and images have been researched as ego-dystonic obsessions for individuals with OCD (Rachamalla et al., 2017; Wetzler et al., 2007). The current study and recent reports (Chaudhary et al., 2016) suggest the importance of assessing ego-syntonic thoughts of suicide in individuals with OCD.

Suicidal ideation at a given time point did not predict OCD at a subsequent observation. One possibility is that for patients with OCD,

there are numerous predictors of symptom severity. Examples in the literature include the severity of behavioral avoidance (Wheaton et al., 2018), exposure to trauma and life stressors (van Oudheusden et al., 2018) and degree of family accommodation of OCD symptoms (Turner et al., 2018). Perhaps within the confines of a selected disorder, the prediction of general disorder severity is more complicated than the prediction of secondary related characteristics, like suicidal thoughts.

Several important methodological features differentiate the current study from prior reports. First, the current study included a wide range of OCD severity. Many individuals had a history of OCD despite not meeting full criteria for the disorder at the time of study initiation. This allowed for a more comprehensive understanding of how suicidal ideation fluctuates in response to variation in OCD symptom severity. In contrast, many prior studies used a dichotomous diagnosis in their associations with suicide risk (Apter et al., 2003; Bolton et al., 2008; Sareen et al., 2005), which reduces power. Second, the current study leveraged a longitudinal design; in contrast, many prior reports have used cross-sectional designs (Simon et al., 2007; Apter et al., 2003). By definition, cross-sectional associations are not equipped to indicate prospective associations (Mann, 2003). Thus, it is possible that OCD symptom severity is not correlated with suicidal ideation at a concurrent observation, yet is a predictor of future suicidal ideation and is therefore of high importance for risk detection. In support of this, the cross-sectional associations between OCD severity and suicidal ideation severity in the current study were modest ($r = 0.26–0.40$). Third, prior reports largely relied on recruitment from the general population (Bolton et al., 2008; Sareen et al., 2005; ten Have et al., 2009) and

outpatient samples (Simon et al., 2007). In contrast, this study recruited participants across levels of care. While many of the included participants were not psychiatric inpatients, recruitment at this facility provided unparalleled access to patients with very severe OCD.

An examination of the autoregressive parameters revealed that OCD symptoms were more stable over time compared to suicidal ideation. In other words, OCD symptom severity in a given year was a more reliable predictor of OCD in the subsequent year than was suicidal ideation as a predictor of subsequent suicidal ideation. Prior research has demonstrated that suicidal ideation tends to vary significantly over time (Depp et al., 2017; Thompson et al., 2014). Theoretical models like Rudd's Fluid Vulnerability Model (Rudd, 2006) account for this variation in suicidal ideation by considering both trait and state risk factors for suicide, both of which contribute to fluctuations in suicidal ideation over time. Despite this, OCD symptoms remained a significant predictor of subsequent suicidal ideation.

There are several features of OCD that are consistent with theoretical models of risk for suicide and that may explain the prediction of suicidal ideation from OCD. For instance, psychological pain (Shneidman, 1993) like that of obsession-related distress is conceptualized as a risk factor for suicide in the Three-Step Theory of Suicide (Klonsky and May, 2015). The chronic pain resulting from OCD may operate as a chronic risk factor for suicide according to Rudd's Fluid Vulnerability theory of suicide (Rudd, 2006). In addition, certain types of obsessions and compulsions may be related to higher risk for suicide. For instance, some evidence suggests that sexual or violent obsessions are associated with risk for suicide attempts (Ching et al., 2017; Dell'Osso et al., 2012; Velloso et al., 2016). This should be explored in future research. Finally, OCD is associated with depression and hopelessness (Kolada et al., 1994; Pinto et al., 2006), each of which increases risk for suicidal ideation (Balci and Sevincok, 2010; Gupta et al., 2014; Kamath et al., 2007; Storch et al., 2017; Velloso et al., 2016). Future research should explore whether depression, hopelessness, or other clinical characteristics serve as mediators or moderators of the association between OCD severity and suicidal ideation over time.

Several limitations require consideration. First, the study relied on a single-item measure of suicidal ideation. However, many prior reports have used a single-item measure of suicidal ideation, including the item used in the current study, which has been strongly associated with future suicide risk in prior studies (Bryan, 2018; Pu et al., 2017; Yang et al., 2017; Green et al., 2015; Goldney, 1979). Furthermore, prior research has demonstrated an association between different single-item measures of suicidal ideation (Vande Voort et al., 2017) and also between single-items and more comprehensive measures (Ballard et al., 2015). Nevertheless, this study requires replication with a more comprehensive measure of suicidality. Second, suicidal ideation was only measured annually, and the percentage of missing data increased with each year, as is typical for longitudinal studies, with only 32% of available data at this point compared to baseline. It is possible that more frequent assessments may reveal a different pattern of associations between OCD and suicide risk. For instance, prior ecological momentary assessment (EMA) research has found that long-term predictors of suicide risk, like depression and hopelessness, are not powerful near-term predictors of suicide risk (Kleiman et al., 2017). Therefore, future research should employ EMA to understand the near-term fluctuations in suicide risk in individuals with OCD. However, participants in the current study were measured over the course of six years, which is an important strength of the study, and EMA might not be feasible over this time frame. Third, the study included only adults. Therefore, the results may not generalize to children and adolescents. Additionally, while the suicide item that was included in the study assesses suicide attempts, this level of severity was not endorsed for any participants. Over the course of the study, two suicide deaths occurred, and three suicide attempts were reported. While suicide attempts are generally rare, it is possible that the low rate of suicide attempts

observed in this study was due to reduced risk due to the assessments, recruitment of a low-risk sample, missed suicide attempts, or that this low rate is reflective of the genuine presentation for OCD. Therefore, the association between OCD symptoms and suicide attempts could not be ascertained. Further, the MHRSD measures thoughts of life not being worth living, wishes for one's own death, suicide attempts, and suicidal ideation/gestures, which are collapsed into one category. Thus, for some participants, this response reflected suicidal ideation alone, whereas for others this reflected some level of suicidal behaviors. Others reported on thoughts of life not being worth living, which is important for understanding suicide risk but which may be distinct from suicidal ideation. In one recent study of thoughts of death and thoughts of suicide in a sample with PTSD, these two constructs changed in consort (Brown et al., 2018). Future research should explore the correlation between these constructs in OCD. Finally, it is possible that a third variable accounts for the association between OCD symptoms and suicide risk. For instance, prior studies found that individuals with OCD were at higher risk for suicide attempts if they had a history of childhood trauma or PTSD (Khosravani et al., 2017; Dell'Osso et al., 2017). We did not explicitly control for third variables of potential interest, including depression or other types of anxiety-related pathology, because of the challenge in adding additional variables into our already complex statistical models. Future studies should therefore explore the directional relationship between OCD and suicidal ideation after accounting for comorbidities, which was not possible in the current study due to limited power.

Clinically, the current study indicates that suicidal ideation is an important area for assessment. There are several psychometrically valid instruments that clinicians can use to assess suicidal ideation (Nock et al., 2007; Posner et al., 2011). In the event that a patient endorses suicidal ideation, brief evidence-based interventions reduce suicide risk, including safety planning (Stanley et al., 2015) and crisis response planning (Bryan et al., 2017). However, because of the limited data on the association between OCD and suicide risk in general, these interventions have not been formally tested in an OCD sample. Nevertheless, clinicians should consider providing both evidence-based OCD and suicide treatments for patients who endorse suicidal ideation, as suicide risk may not resolve until OCD symptoms are effectively managed. In instances of imminent suicide risk, this needs to be prioritized clinically, including exploring the possibility of psychiatric hospitalization or residential treatment to ensure safety. This action might be indicated in instances of a history of suicidal behavior or in the presence of other comorbidities, including depression, which may increase risk.

In summary, this study is the first of its kind to demonstrate that OCD symptom severity is predictive of future suicidal ideation. In contrast, suicidal ideation was not predictive of future OCD symptom severity. Clinically, these findings indicate the importance of both assessing and addressing suicidal ideation in the treatment of OCD. Future research should explore the impact of evidence-based treatments for OCD on suicidal ideation outcomes for individuals at risk for suicide.

Potential competing interests

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References

- Angelakis, I., Gooding, P., Tarrier, N., Panagioti, M., 2015. Suicidality in obsessive compulsive disorder (OCD): a systematic review and meta-analysis. *Clin. Psychol. Rev.* 39, 1–15. <https://doi.org/10.1016/j.cpr.2015.03.002>.
- Apter, A., Horesh, N., Gotthelf, D., Zalsman, G., Erlich, Z., Soreni, N., Weizman, A., 2003. Depression and suicidal behavior in adolescent inpatients with obsessive compulsive disorder. *J. Affect. Disord.* 75, 181–189.
- American Psychiatric Association, 2013. *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition. American Psychiatric Association, Washington, DC.
- Balci, V., Sevincok, L., 2010. Suicidal ideation in patients with obsessive-compulsive disorder. *Psychiatry Res.* 175, 104–108. <https://doi.org/10.1016/j.psychres.2009.03.012>.
- Ballard, E.D., Luckenbaugh, D.A., Richards, E.M., Walls, T.L., Brutsche, N.E., Ameli, R., Niciu, M.J., Vande Voort, J.L., Zarate Jr., C.A., 2015. Assessing measures of suicidal ideation in clinical trials with a rapid-acting antidepressant. *J. Psychiatr. Res.* 68, 68–73. <https://doi.org/10.1016/j.jpsychres.2015.06.003>.
- Bentley, K.H., Franklin, J.C., Ribeiro, J.D., Kleiman, E.M., Fox, K.R., Nock, M.K., 2016. Anxiety and its disorders as risk factors for suicidal thoughts and behaviors: a meta-analytic review. *Clin. Psychol. Rev.* 43, 30–46. <https://doi.org/10.1016/j.cpr.2015.11.008>.
- Bolton, J.M., Cox, B.J., Afifi, T.O., Enns, M.W., Bienvenu, O.J., Sareen, J., 2008. Anxiety disorders and risk for suicide attempts: findings from the Baltimore Epidemiologic Catchment area follow-up study. *Depress. Anx.* 25, 477–481. <https://doi.org/10.1002/da.20314>.
- Brakoulias, V., Starcevic, V., Belloch, A., Brown, C., Ferrao, Y.A., Fontenelle, L.F., Lochner, C., Marazziti, D., Matsunaga, H., Miguel, E.C., Reddy, Y.C.J., Rosario, M.C., Shavitt, R.G., Sundar, S.A., Stein, D.J., Torres, A.R., Viswasam, K., 2017. Comorbidity, age of onset and suicidality in obsessive-compulsive disorder (OCD): an international collaboration. *Compr. Psychiatry* 76, 79–86. <https://doi.org/10.1016/j.comppsy.2017.04.002>.
- Brown, L.A., Arney, M.A., Sejourne, C., Miller, I.W., Weinstock, L.M., 2016. Trauma history is associated with prior suicide attempt history in hospitalized patients with major depressive disorder. *Psychiatry Res.* 243, 191–197.
- Brown, L.A., Gaudiano, B.A., Miller, I.W., 2010. The impact of panic-agoraphobic comorbidity on suicidality in hospitalized patients with major depression. *Depress. Anxiety* 27, 310–315.
- Brown, L.A., Jerud, A., Petersen, J., Zang, Y., Foa, E.B., 2018. Changes in PTSD and depressive symptoms over the course of prolonged exposure. *J. Consult. Clin. Psychol.* 86 (5), 452–463.
- Bryan, C.J., 2018. A preliminary validation study of two ultra-brief measures of suicide risk: the Suicide and Perceived Burdensomeness Visual Analog Scales Suicide & life-threatening behavior. <https://doi.org/10.1111/sltb.12447>.
- Bryan, C.J., Mintz, J., Clemons, T.A., Leeson, B., Burch, T.S., Williams, S.R., Maney, E., Rudd, M.D., 2017. Effect of crisis response planning vs. contracts for safety on suicide risk in U.S. Army Soldiers: a randomized clinical trial. *J. Affect. Disord.* 212, 64–72. <https://doi.org/10.1016/j.jad.2017.01.028>.
- Centers for Disease Control and Prevention, 2014. *Data & Statistics Fatal Injury Report for 2014*.
- Chaudhary, R.K., Kumar, P., Mishra, B.P., 2016. Depression and risk of suicide in patients with obsessive-compulsive disorder: A hospital-based study. *Ind. Psychiatry J.* 25, 166–170. <https://doi.org/10.4103/ijp.ipj.63.16>.
- Ching, T.H., Williams, M., Stev, J., 2017. Violent obsessions are associated with suicidality in an OCD analog sample of college students. *Cogn. Behav. Ther.* 46, 129–140. <https://doi.org/10.1080/16506073.2016.1228084>.
- Dell'Osso, B., Benatti, B., Arici, C., Palazzo, C., Altamura, A.C., Hollander, E., Fineberg, N., Stein, D.N., Nicolini, H., Lanzagorta, N., Marazziti, D., Pallanti, S., van Ameringen, M., Lochner, C., Karamustafalioglu, O., Hranov, L., Figeo, M., Drummond, L., Rodriguez, C.I., Grant, J., Denys, D., Menchon, J.M., Zohar, J., 2017. Prevalence of suicide attempt and clinical characteristics of suicide attempters with obsessive-compulsive disorder: a report from the International College of Obsessive-Compulsive Spectrum Disorders (ICOCS). *CNS Spectr.* 11, 1–8. <https://doi.org/10.1017/s1092852917000177>.
- Dell'Osso, L., Casu, G., Carlini, M., Conversano, C., Gremigni, P., Carmassi, C., 2012. Sexual obsessions and suicidal behaviors in patients with mood disorders, panic disorder, and schizophrenia. *Ann. Gen. Psychiatry* 11. <https://doi.org/11.1186/1744-859X-11-27>.
- Depp, C.A., Thompson, W.K., Frank, E., Swartz, H.A., 2017. Prediction of near-term increases in suicidal ideation in recently depressed patients with bipolar II disorder using internet longitudinal data. *J. Affect. Disord.* 208, 363–368. <https://doi.org/10.1016/j.jad.2016.09.054>.
- Eisen, J.L., Pinto, A., Mancebo, M.C., Dyck, I.R., Orlando, M.E., Rasmussen, S.A., 2010. A 2-year prospective follow-up study of the course of obsessive-compulsive disorder. *J. Clin. Psychiatry* 71, 1033–1039. <https://doi.org/10.4088/JCP.08m04806blu>.
- Eisen, J.L., Sibrava, N.J., Boisseau, C.L., Mancebo, M.C., Stout, R.L., Pinto, A., Rasmussen, S.A., 2013. Five-year course of obsessive-compulsive disorder: predictors of remission and relapse. *J. Clin. Psychiatry* 74, 233–239. <https://doi.org/10.4088/JCP.12m07657>.
- Fernández de la Cruz, L., Rydell, M., Runeson, B., D'Onofrio, B.M., Brander, G., Rück, C., Lichtenstein, P., Larsson, H., Mataix-Cols, D., 2017. Suicide in obsessive-compulsive disorder: a population-based study of 36,788 Swedish patients. *Mol. Psychiatry* 22, 1626–1632. <https://doi.org/10.1038/mp.2016.115>.
- Goldney, R.D., 1979. Assessment of suicidal intent by a visual analogue scale. *Aust. N. Z. J. Psychiatry* 13, 153–155. <https://doi.org/10.3109/00048677909159128>.
- Goodman, W.K., Price, L.H., Rasmussen, S.A., Mazure, C., Fleischmann, R.L., Hill, C.L., Heninger, G.R., Charney, D.S., 1989a. The yale-brown obsessive compulsive scale: I. development, use, and reliability. *Arch. Gen. Psychiatry* 46, 1006–1011. <https://doi.org/10.1001/archpsyc.1989.01810110048007>.
- Goodman, W.K., Price, L.H., Rasmussen, S.A., Mazure, C., Delgado, P., Heninger, G.R., Charney, D.S., 1989b. The yale-brown obsessive compulsive scale. II. Validity. *Arch. Gen. Psychiatry* 46, 1012–1016.
- Green, K.L., Brown, G.K., Jager-Hyman, S., Cha, J., Steer, R.A., Beck, A.T., 2015. The predictive validity of the beck depression inventory suicide item. *J. Clin. Psychiatry* 76, 1683–1686. <https://doi.org/10.4088/JCP.14m09391>.
- Gupta, G., Avasthi, A., Grover, S., Singh, S.M., 2014. Factors associated with suicidal ideations and suicidal attempts in patients with obsessive compulsive disorder. *Asian J. Psychiatr.* 12, 140–146. <https://doi.org/10.1016/j.ajp.2014.09.004>.
- Harris, E.C., Barraclough, B., 1997. Suicide as an outcome for mental disorders. A meta-analysis. *Br. J. Psychiatry* 170, 205–228.
- Hofer, P.D., Wahl, K., Meyer, A.H., Miche, M., Beeso-Baum, K., Wong, S.F., Grisham, J.R., Wittchen, H.U., Lieb, R., 2018. Obsessive-compulsive disorder and the risk of subsequent mental disorders: a community study of adolescents and young adults. *Depress. Anxiety* 35, 339–345. <https://doi.org/10.1002/da.22733>.
- Hofmann, S.G., Asnaani, A., Vonk, I.J., Sawyer, A.T., Fang, A., 2012. The efficacy of cognitive behavioral therapy: a review of meta-analyses. *Cognit. Ther. Res.* 36, 427–440. <https://doi.org/10.1007/s10608-012-9476-1>.
- Hollander, E., Greenwald, S., Neville, D., Johnson, J., Hornig, C.D., Weissman, M.M., 1996. Uncomplicated and comorbid obsessive-compulsive disorder in an epidemiologic sample. *Depress. Anxiety* 4, 111–119. doi:10.1002/(sici)1520-6394(1996)4:3<111::aid-da3>3.0.co;2-j.
- Kamath, P., Reddy, Y.C., Kandavel, T., 2007. Suicidal behavior in obsessive-compulsive disorder. *J. Clin. Psychiatry* 68, 1741–1750.
- Kanwar, A., Malik, S., Prokop, L.J., Sim, L.A., Feldstein, D., Wang, Z., Murad, M.H., 2013. The association between anxiety disorders and suicidal behaviors: a systematic review and meta-analysis. *Depress. Anxiety* 30, 917–929. <https://doi.org/10.1002/da.22074>.
- Khosravi, V., Kamali, Z., Jamaati Ardakani, R., Samimi Ardestani, M., 2017. The relation of childhood trauma to suicide ideation in patients suffering from obsessive-compulsive disorder with lifetime suicide attempts. *Psychiatry Res.* 255, 139–145. <https://doi.org/10.1016/j.psychres.2017.05.032>.
- Kleiman, E.M., Turner, B.J., Fedor, S., Beale, E.E., Huffman, J.C., Nock, M.K., 2017. Examination of real-time fluctuations in suicidal ideation and its risk factors: results from two ecological momentary assessment studies. *J. Abnorm. Psychol.* 126, 726–738. <https://doi.org/10.1037/abn0000273>.
- Klonsky, E.D., May, A.M., 2015. The Three-Step Theory (3ST): a new theory of suicide rooted in the "Ideation-to-Action" framework. *Int. J. Cognit. Therapy* 8, 114–129.
- Kolada, J.L., Bland, R.C., Newman, S.C., 1994. Obsessive-compulsive disorder. *Acta Psychiatr. Scand.* 89, 24–35. <https://doi.org/10.1111/j.1600-0447.1994.tb05788.x>.
- Mancebo, M.C., Eisen, J.L., Pinto, A., Greenberg, B.D., Dyck, I.R., Rasmussen, S.A., 2006. The brown longitudinal obsessive compulsive study: treatments received and patient impressions of improvement. *J. Clin. Psychiatry* 67 (11), 1713–1720.
- Mann, C.J., 2003. Observational research methods. Research design II: cohort, cross sectional, and case-control studies. *Emerg. Med. J.* 20, 54–60. <https://doi.org/10.1136/emj.20.1.54>.
- Martens, M.P., Haase, R.F., 2006. Advanced applications of structural equation modeling in counseling psychology research. *Couns. Psychol.* 34, 878–911. <https://doi.org/10.1177/001100005283395>.
- Meier, S.M., Mattheisen, M., Mors, O., Schendel, D.E., Mortensen, P.B., Plessen, K.J., 2016. Mortality among persons with obsessive-compulsive disorder in Denmark. *JAMA Psychiatry* 73, 268–274. <https://doi.org/10.1001/jamapsychiatry.2015.3105>.
- Meyer, J.M., Farrell, N.R., Kemp, J.J., Blakey, S.M., Deacon, B.J., 2014. Why do clinicians exclude anxious clients from exposure therapy? *Behav. Res. Therapy* 54, 49–53. <https://doi.org/10.1016/j.brat.2014.01.004>.
- Miller, I.W., Bishop, S., Norman, W.H., Maddever, H., 1985. The modified hamilton rating scale for depression: reliability and validity. *Psychiatry Res.* 14, 131–142.
- Muthén, L.K., Muthén, B.O., 2012. *Mplus User's Guide*, 7th Edition. Muthén & Muthén, Los Angeles, CA.
- Nock, M.K., Holmberg, E.B., Photos, V.I., Michel, B.D., 2007. Self-injurious thoughts and behaviors interview: development, reliability, and validity in an adolescent sample. *Psychol. Assess.* 19, 309–317. <https://doi.org/10.1037/1040-3590.19.3.309>.
- Nordahl, H., Havnen, A., Hansen, B., Ost, L.G., Kvale, G., 2018. Sleep disturbances in treatment-seeking OCD-patients: changes after concentrated exposure treatment. *Scand. J. Psychol.* 59, 186–191. <https://doi.org/10.1111/sjop.12417>.
- Pinto, A., Mancebo, M.C., Eisen, J.L., Pagano, M.E., Rasmussen, S.A., 2006. The brown longitudinal obsessive compulsive study: clinical features and symptoms of the sample at intake. *J. Clin. Psychiatry* 67, 703–711. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3272757/>.
- Posner, K., Brown, G.K., Stanley, B., Brent, D.A., Yershova, K., Oquendo, M.A., 2011. The Columbia-Suicide Severity Rating Scale: internal validity and internal consistency findings from three multisite studies with adolescents and adults. *Am. J. Psychiatry* 168, 1266–1277.
- Pu, S., Setoyama, S., Noda, T., 2017. Association between cognitive deficits and suicidal ideation in patients with major depressive disorder. *Sci. Rep.* 7, 11637. <https://doi.org/10.1038/s41598-017-12142-8>.
- Rachamalla, V., Song, M.M., Liu, H., Giles, C.L., McMahon, T., 2017. Obsessive-compulsive disorder with suicide obsessions in a first responder without previous diagnosis of OCD or history of suicide attempts. *Case Rep. Psychiatry* 2017. <https://doi.org/10.1155/2017/4808275>.
- Rudd, M.D., 2006. *Fluid Vulnerability Theory: A Cognitive Approach to Understanding the Process of Acute and Chronic Suicide Risk Cognition and suicide: Theory, research, and Therapy*. US: American Psychological Association, Washington, DC, pp.

- 355–368.
- Ruscio, A.M., Stein, D.J., Chiu, W.T., Kessler, R.C., 2010. The epidemiology of obsessive-compulsive disorder in the national comorbidity survey replication. *Mol. Psychiatry* 15, 53–63. <https://doi.org/10.1038/mp.2008.94>.
- Sareen, J., Cox, B.J., Afifi, T.O., de Graaf, R., Asmundson, G.J., Have, M., Stein, M.B., 2005. Anxiety disorders and risk for suicidal ideation and suicide attempts: a population-based longitudinal study of adults. *Arch. Gen. Psychiatry* 62, 1249–1257. <https://doi.org/10.1001/archpsyc.62.11.1249>.
- Shneidman, E.S., 1993. Commentary: suicide as psychache. *J. Nerv. Mental Dis.* 181, 145–147. Retrieved from. http://journals.lww.com/jonmd/Fulltext/1993/03000/Commentary_Suicide_as_Psychache.1.aspx.
- Simon, N.M., Zalta, A.K., Otto, M.W., Ostacher, M.J., Fischmann, D., Chow, C.W., Thompson, E.H., Stevens, J.C., Demopulos, C.M., Nierenberg, A.A., Pollack, M.H., 2007. The association of comorbid anxiety disorders with suicide attempts and suicidal ideation in outpatients with bipolar disorder. *J. Psychiatr. Res.* 41, 255–264. <https://doi.org/10.1016/j.jpsychires.2006.08.004>.
- Stanley, B., Brown, G.K., Currier, G.W., Lyons, C., Chesin, M., Knox, K.L., 2015. Brief intervention and follow-up for suicidal patients with repeat emergency department visits enhances treatment engagement. *Am. J. Public Health* 105, 1570–1572. <https://doi.org/10.2105/ajph.2015.302656>.
- Storch, E.A., Kay, B., Wu, M.S., Nadeau, J.M., Riemann, B., 2017. Suicidal and death ideation among adults with obsessive-compulsive disorder presenting for intensive intervention. *Ann. Clin. Psychiatry* 29, 46–53.
- Have, M., de Graaf, R., van Dorsselaer, S., Verdurmen, J., van 't Land, H., Vollebergh, W., Beekman, A., 2009. Incidence and course of suicidal ideation and suicide attempts in the general population. *Can. J. Psychiatry* 54, 824–833. <https://doi.org/10.1177/070674370905401205>.
- Thompson, W.K., Gershon, A., O'Hara, R., Bernert, R.A., Depp, C.A., 2014. The prediction of study-emergent suicidal ideation in bipolar disorder: a pilot study using ecological momentary assessment data. *Bipolar Disord.* 16, 669–677. <https://doi.org/10.1111/bdi.12218>.
- Toftdahl, N.G., Nordentoft, M., Hjorthøj, C., 2016. Prevalence of substance use disorders in psychiatric patients: a nationwide Danish population-based study. *Soc. Psychiatry Psychiatr. Epidemiol.* 51, 129–140. <https://doi.org/10.1007/s00127-015-1104-4>.
- Torres, A.R., Ramos-Cerqueira, A.T., Ferrao, Y.A., Fontenelle, L.F., do Rosario, M.C., Miguel, E.C., 2011. Suicidality in obsessive-compulsive disorder: prevalence and relation to symptom dimensions and comorbid conditions. *J. Clin. Psychiatry* 72, 17–26. <https://doi.org/10.4088/JCP.09m05651blu>. quiz 119–120.
- Turner, C., O'Gorman, B., Nair, A., O'Kearney, R., 2018. Moderators and predictors of response to cognitive behaviour therapy for pediatric obsessive-compulsive disorder: a systematic review. *Psychiatry Res.* 261, 50–60. <https://doi.org/10.1016/j.psychres.2017.12.034>.
- van Oudheusden, L.J.B., Eikelenboom, M., van Megen, H., Visser, H.A.D., Schruers, K., Hendriks, G.J., van der Wee, N., Hoogendoorn, A.W., van Oppen, P., van Balkom, A., 2018. Chronic obsessive-compulsive disorder: prognostic factors. *Psychol. Med.* 1–10. <https://doi.org/10.1017/s0033291717003701>.
- Vande Voort, J.L., Ballard, E.D., Luckenbaugh, D.A., Bernert, R.A., Richards, E.M., Niciu, M.J., Park, L.T., Machado-Vieira, R., Duncan, W.C., Zarate, C.A., 2017. Antisuicidal response following ketamine infusion is associated with decreased nighttime wakefulness in major depressive disorder and bipolar disorder. *J. Clin. Psychiatry* 78, 1068–1074. <https://doi.org/10.4088/JCP.15m10440>.
- Velloso, P., Piccinato, C., Ferrao, Y., Aliende Perin, E., Cesar, R., Fontenelle, L., Hounie, A.G., do Rosario, M.C., 2016. The suicidality continuum in a large sample of obsessive-compulsive disorder (OCD) patients. *Eur. Psychiatry* 38, 1–7. <https://doi.org/10.1016/j.eurpsy.2016.05.003>.
- Wetzler, A.J., Elias, R., Fostick, L., Zohar, J., 2007. Suicidal ideation versus suicidal obsession: a case report. *CNS Spectr.* 12, 553–556.
- Wheaton, M.G., Gershkovich, M., Gallagher, T., Foa, E.B., Simpson, H.B., 2018. Behavioral avoidance predicts treatment outcome with exposure and response prevention for obsessive-compulsive disorder. *Depress. Anxiety.* <https://doi.org/10.1002/da.22720>.
- Yang, Y., Shi, Y.Z., Zhang, N., Wang, S., Ungvari, G.S., Ng, C.H., Wang, Y.L., Zhao, X.Q., Wang, Y.J., Wang, C.X., Xiang, Y.T., 2017. Suicidal ideation at 1-year post-stroke: a nationwide survey in China. *Gen. Hosp. Psychiatry* 44, 38–42. <https://doi.org/10.1016/j.genhospsych.2016.09.006>.