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Review article

Rumination in major depressive and bipolar disorder – a meta-analysis

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A B S T R A C T

Background: rumination, defined as repetitive thoughts about emotionally relevant experiences, has been linked extensively with mood disorders, especially major depressive disorder (MDD).[1] However, there is a growing body of evidence suggesting the importance of rumination in bipolar disorder (BD)[2] as well.
Methods: we searched for studies that investigated rumination in both BD and MDD in four databases. Our systematic search identified 12 studies with an overall sample size of 2071 clinical patients.
Results: results demonstrated no significant difference in the ruminative tendencies of the two patient groups when all rumination measures were included. We tested for the effect of rumination subtype, BD subgroups, and the current mood state of BD and MDD patients. There were no significant differences in terms of depressive rumination, however, BD patients reported more rumination on positive affect. This difference remained significant when examining in BD-I[3] and BD-II[4] patient groups, with similar effect sizes.
Limitations: due to the lack of sufficient data in the literature, only a few self-report studies qualified to be included in our analysis. Thus additional moderating factors, such as the current mood state of the two patient groups could not be analyzed.
Conclusions: this review demonstrates that rumination is a significant process in both MDD and BD, highlighting the importance of interventions to reduce rumination in mood disorders. The two patient groups share several commonalities in terms of rumination, however, rumination subtype was found to be an important moderating variable underlining a difference in rumination on positive affect.

1. Introduction

Depressive disorders are extremely common conditions that, especially when untreated, cause huge burdens on the level of the individual as well as the society (Malhi et al., 2015). The two primary manifestations of depressive disorders are major depressive disorder (MDD) and bipolar disorder (BD). While the most common features of MDD are severely depressed mood and the incapability of showing interest or experiencing pleasure, BD conditions are characterized by acute dysfunctional mood states of mania (in bipolar I disorder - BD-I) or hypomania (bipolar II disorder - BD-II), with or without depressive episodes (American Psychiatric Association, 2013). MDD is the most common mental disorder, with an estimated lifetime prevalence of 16% (Angst et al., 2011; Kessler et al., 2003), and while BD (including both subtypes) is considered much less prevalent (approximately 0.9 −2.1% (Hirschfeld et al., 2002)), it is important to note that BD conditions are often mistakenly diagnosed as MDD, where the manic pole remains unnoticed and therefore untreated (Angst et al., 2011). This may be due to the fact that BD patients tend to develop depressive episodes more frequently and for longer times than [hypo]manic episodes (Judd et al., 2002), during which they experience severe relational and occupational disabilities (Calabrese et al., 2004), thus they tend to seek help during their depressed phase. Prospective studies show that patients who initially seek help with MDD have a high risk of developing manic or hypomanic features over the upcoming years (Goldberg et al., 2001).

The various types of BD lie along a spectrum ranging from milder cyclothymic conditions to BD-II, and to the most severe BD-I (Goodwin and Jamison, 2007), where the early milder manifestations of the disorder may shift towards the more severe end of the continuum over time (Shen et al., 2008). Congruently, a growing body of evidence

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[1] MDD: major depressive disorder
[2] BD: bipolar disorder
[3] BD-I: bipolar I disorder
[4] BD-II: bipolar II disorder

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indicates that MDD is a rather heterogeneous condition with frequent subliminal [hypo]manic features (Zimmermann et al., 2009). This phenomenon is also reflected by the numerous mixed or overlapping diagnostic categories within mood disorders listed in the DSM-5 (American Psychiatric Association, 2013), posing that depressive disorders are hard to consider distinct nosological categories, and should rather be conceptualized dimensionally (Benazzi, 2006). Furthermore, the dimensional approach of mood disorders, as suggested for instance by the Research Domain Criteria, is more likely to yield a better understanding of their etiology than the categorical view (Frank, 2011). In the same vein, MDD and BD patients exhibit numerous features in common, such as impairments in cognitive performance (Baune and Malhi, 2015; Yen et al., 2011), elevated use of negative cognitive biases (Rowland et al., 2013; Rude et al., 2003), as well as the extensive use of rumination (Green et al., 2011), which together may indicate impaired inhibitory executive function both in BD and MDD (Joormann and Gotlib, 2010). However, currently there is a lack of consensus whether BD and MDD share the same cognitive-emotional features with quantitative differences or they rather represent distinct nosological categories with qualitatively diverse neuropsychological background (Samamé et al., 2017). This current debate supports the need for studies that systematically compare rumination in BD and MDD.

Rumination is a transdiagnostic emotion regulation strategy that has been associated with various forms of psychopathology such as depression, anxiety, substance abuse, binge eating, and self-injurious behavior (McLaughlin et al., 2014). According to the Response Style Theory (Nolen-Hoeksema, 1991), the most widely used conceptualization of rumination (Smith and Alloy, 2009), people characterized by a ruminative response style tend to react to their own negative mood states by dwelling on them passively and repeatedly (Nolen-Hoeksema, 2000), which is also referred to as depressive rumination. It is well-established that rumination further increases depressive symptoms (Brinker and Dozois, 2009; Nolen-Hoeksema et al., 1993), and it can be considered as a predictor of the onset (Nolen-Hoeksema et al., 2008), severity (Lam et al., 2003) and reoccurrence (Silveira and Kauer-Sant'Anna, 2015) of major depressive episodes. An example of depressive ruminative thought is “Why am I the only one facing difficulties and suffer from unhappiness?”.

Ruminative response to positive emotional states, i.e. rumination on positive affect and its role in affective disorders has also come to the focus of research (Gilbert, 2012). Ruminating on positive affective states, i.e. constantly recalling rewarding past events and positive mood states amplifies and sustains the positive feeling (Feldman et al., 2008). An example of rumination on positive affect could be “I performed very well at that presentation at work last week”. Ruminating on positive affect may be gratifying on the short term, however, as it fosters positive emotional response even in the lack of positive emotional cues, it may reduce the flexibility in adjusting one's emotional response to the appropriate external stimuli (Gruber et al., 2011).

Although much less studies have focused on rumination in BD or mania than in unipolar depression, its negative impact among these patients is also well-established (Ghaznavi and Deckersbach, 2012). Rumination appears to be more common among BD patients than among their relatives (Green et al., 2011) and healthy controls, even after controlling for current mood state (Alloy et al., 2009), and has been associated with elevated depressive and hypomanic symptoms (Green et al., 2011). Emotion regulation impairment and affective lability are core features of BD in the depressed and the manic phases (Townsend and Altshuler, 2012), as well as in euthymia (Henry et al., 2008). According to a systematic review, rumination accompanies all episodes of BD, aggravating emotion dysregulation and affective lability in both the depressive and the manic phases (Silveira and Kauer-Sant'Anna, 2015). A longitudinal study found that the occurrence of hypomanic or manic episodes among BD patients was not predicted by depressive rumination, meanwhile it did prospectively predict the number of depressive episodes during the 3.5-year long follow-up period (Alloy et al., 2009). This is in line with the notion that both MDD and BD patients tend to engage in depressive rumination, while rumination on positive affect only characterizes BD patients (Johnson et al., 2008), and appears to aggravate their manic symptoms (Carver and Johnson, 2009).

To sum up, extensive amount of research has demonstrated that depressive rumination is strongly associated with depressive symptoms in both MDD and BD (Johnson et al., 2008). Furthermore, a growing body of neurological studies suggest strong associations between rumination on positive affect and manic/hypomanic symptoms that appears to involve disturbed reward processing (Phillips and Vieta, 2007; Rey et al., 2016). In other words, while depressed, MDD and BD patients appear to ruminate on negative mood, while BD patients tend to engage in rumination on positive affect in [hypo]mania (Ghaznavi and Deckersbach, 2012), suggesting that ruminative tendencies, regardless their valence, lead to increased vulnerability to emotional disturbances by magnifying the significance of emotionally relevant events (Alloy et al., 2009). The current study attempts to address possible distinctions and commonalities regarding the ruminative tendencies of the two patient groups with the help of meta-analytic techniques. Based on previous findings, we hypothesized that both patient groups tend to engage in depressive rumination without significant differences, whereas we expected that BD patients report more rumination on positive affect. Because of this, we also hypothesized that BD patients tend to report more rumination in general.

Furthermore, since the level of rumination varies across the different episodes of BD and MDD (Silveira and Kauer-Sant'Anna, 2015; Visted et al., 2018), we were also aiming to test whether the current mood status of MDD (remitted/currently depressed) and BD (euthymia/hypomania/mania/depression) is associated with the level of rumination.

2. Methods

2.1. Search strategy

The full study protocol was pre-registered and is available at Open Science Framework (https://osf.io/hjenm). We applied a systematic literature search in order to find studies that assessed rumination among patients with BD and MDD. The last literature search was conducted on May 30, 2019 until inception in the following databases: PubMed, Science Direct, Web of Science and EBSCO, applying the following search string: ((((ruminat* OR "ruminative thought" OR brooding or pondering))) AND ((bipolar OR mani* OR "manic episode" OR BD or cyclothymi* OR euthymi* OR hypomani*))) AND ((depressi* or MDD OR "major depressive disorder" OR "unipolar depression" OR dysphori* OR dysthymi*)). The reference lists of the identified articles, as well as of relevant reviews and meta-analyses (Dodd et al., 2019; Ghaznavi and Deckersbach, 2012; Silveira and Kauer-Sant'Anna, 2015) were also screened for potential additional studies to include.

2.2. Study selection

We only included studies that recruited a group of patients formally diagnosed with BD, as well as a group of patients formally diagnosed with MDD based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD). We only wished to search for papers published in peer-reviewed journals that were available in English. Furthermore, studies had to contain at least one rumination measure (e.g. self-report rumination questionnaire, ecological momentary assessment studies investigating current level of rumination, treatment studies with baseline rumination assessment, or studies utilizing rumination induction). Review articles and case studies were excluded.

After removing duplicates, 488 studies remained, on which we conducted an initial screening process based on title and abstract.

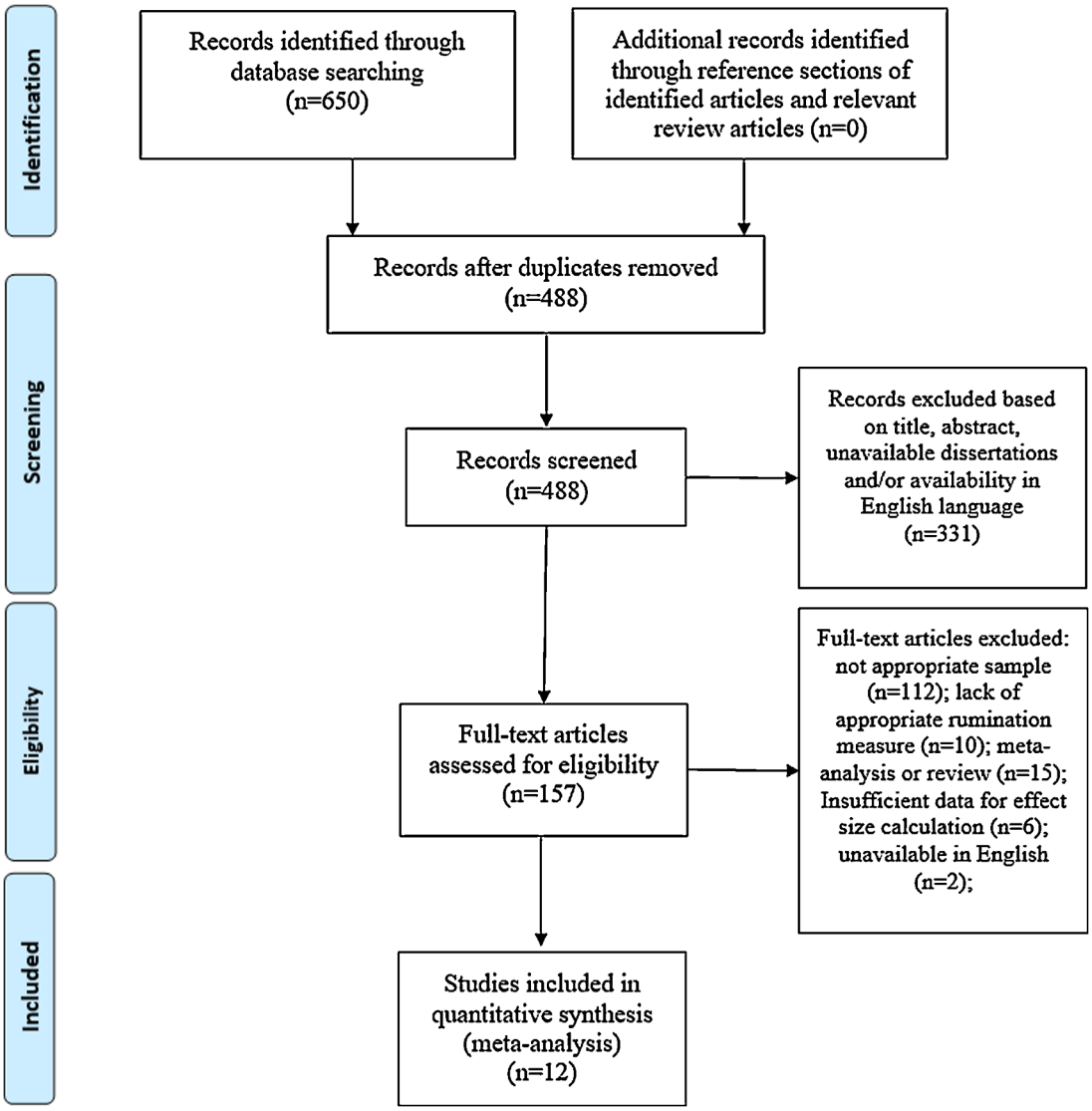

Fig. 1. PRISMA flow diagram of study selection.

During this initial screening 331 studies were excluded. The full texts of the remaining 157 articles were reviewed by two researchers independently in order to determine which articles should be included. We contacted the authors of ten articles to provide data in order to be able to calculate the effect sizes, four of whom provided the necessary data. As shown in Fig. 1, the study selection process resulted in 12 articles (for details see Table 1 below) that could be included in the present analysis, all of which were published in peer-reviewed journals.

2.3. Data extraction

Our systematic search only yielded studies that measured rumination with self-report questionnaires. Four studies assessed rumination on positive affect, all of which applied the Responses to Positive Affect (RPA) Scale (Feldman et al., 2008). The RPA contains two subscales that assess rumination when feeling happy or excited, namely emotion focus, the core feature of which is the pleasant emotional impression, and self-focus, that aims to capture the meaning of a favorable event for the person's confidence and self-esteem. Depressive rumination was assessed by either the rumination subscale of the Response Style Questionnaire (RSQ, Nolen-Hoeksema and Morrow, 1991) (k = 2), or the Ruminative Response Scale (RRS, Treynor et al., 2003) (k = 4), both of which instruct participants to report about their rumination when feeling sad or depressed. Two studies reported the total score of the RRS, two studies reported its brooding subscale, and one study reported its depression subscale. The following rumination measures were also used in the primary studies: the reflection subscale of the RRS (k = 1), the rumination subscale of the Leahy Emotional Schema Scale (LESS, Leahy, 2002) (k = 1), the rumination subscale of the Cognitive Emotion Regulation Questionnaire (CERQ, Garnefski et al., 2001) (k = 2), and the Ruminative Thought Style Questionnaire (RTSQ; Brinker and Dozois, 2009) (k = 1). The reflection subscale of the RRS measures a more adaptive form of rumination, where analyzing feelings and thoughts may help problem solving. The LESS is a self-report emotional schema questionnaire that contains 14 dimensions of emotional response. The rumination subscale of the LESS contains five items (two of which are reversed) that have to be answered on a 6-point Likert-scale. The rumination scale of CERQ assesses ruminative response to stressful events. The RTSQ aims to assess rumination globally, unbiased by depressive symptoms (Brinker and Dozois, 2009). We categorized the questionnaires according to their objectives as depressive rumination, rumination on positive affect, reflection, whereas the additional questionnaires that measure rumination more globally and does not specify the mood state in the instruction were categorized as "rumination not otherwise specified" (NOS). The exact scales used in each study and their classification are shown in Table 1.

Table 1
Summary of reviewed studies (k = 12).

Study name	Country	BD group diagnosis	Rumination scale	Rumination subtype	Rumination score BD		MDD		HC		Current BD episode	Current MDD episode	Rumination scale reliability
					n	M (SD)	n	M (SD)	n	M (SD)			
Batmaz et al., 2014	Turkey	BD I	LESS rumination subscale	Rumination NOS	140	19.22 (3.16)	166	19.59 (3.80)	151	14.86 (3.98)	mix	not reported	not reported
Fletcher et al., 2013	Australia	BD I	CERQ rumination subscale	Rumination NOS	86	13.70 (3.30)	96	14.50 (3.40)	90	10.40 (3.20)	not reported	not reported	not reported
Fletcher et al., 2013	Australia	BD I	RPA emotion focus subscale	Rumination on positive affect	86	13.70 (3.30)	96	12.30 (3.30)	90	41.40 (9.40)	not reported	not reported	>0.70
Fletcher et al., 2013	Australia	BD I	RPA self-focus subscale	Rumination on positive affect	86	9.40 (2.70)	96	8.40 (2.50)	90	13.20 (3.20)	not reported	not reported	>0.70
Fletcher et al., 2013	Australia	BD I	RSQ rumination subscale	Depressive rumination	86	63.80 (13.1)	96	63.40 (11.3)	90	9.70 (2.50)	not reported	not reported	not reported
Fletcher et al., 2013	Australia	BD II	CERQ rumination subscale	Rumination NOS	107	14.00 (3.40)	96	14.50 (3.40)	90	10.40 (3.20)	not reported	not reported	not reported
Fletcher et al., 2013	Australia	BD II	RPA emotion focus subscale	Rumination on positive affect	107	13.80 (3.90)	96	12.30 (3.30)	90	41.40 (9.40)	not reported	not reported	>0.70
Fletcher et al., 2013	Australia	BD II	RPA self-focus subscale	Rumination on positive affect	107	9.30 (3.20)	96	8.40 (2.50)	90	13.20 (3.20)	not reported	not reported	>0.70
Fletcher et al., 2013	Australia	BD II	RSQ rumination subscale	Depressive rumination	107	65.80 (12.9)	96	63.40 (11.3)	90	9.70 (2.50)	not reported	not reported	not reported
Forgeard et al., 2018	USA	mix	RRS brooding subscale	Depressive rumination	60	11.98 (3.81)	122	12.38 (3.50)	—	—	mix	mix	>0.70
Forgeard et al., 2018	USA	mix	RRS depression subscale	Depressive rumination	60	29.32 (9.40)	121	31.28 (7.80)	—	—	mix	mix	not reported
Forgeard et al., 2018	USA	mix	RRS reflection subscale	Reflection	60	11.50 (3.68)	121	11.36 (3.07)	—	—	mix	mix	>0.70
Gilbert et al., 2013	USA	BD I	RPA emotion focus subscale	Rumination on positive affect	31	14.26 (3.66)	31	13.29 (3.57)	—	—	remitted/ euthymic	remitted	>0.70
Gilbert et al., 2013	USA	BD I	RPA self-focus subscale	Rumination on positive affect	31	10.29 (3.39)	31	9.16 (3.06)	—	—	remitted/ euthymic	Blank	>0.70
Hanssen et al., 2018	Netherlands	BD I	RPA emotion focus subscale	Rumination on positive affect	96	13.13 (2.71)	175	10.52 (3.45)	—	—	mix	mix	>0.70
Hanssen et al., 2018	Netherlands	BD I	RPA self-focus subscale	Rumination on positive affect	96	8.65 (2.66)	175	7.23 (3.15)	—	—	mix	mix	>0.70
Hanssen et al., 2018	Netherlands	BD II	RPA emotion focus subscale	Rumination on positive affect	27	12.93 (2.69)	175	10.52 (3.45)	—	—	mix	mix	>0.70
Hanssen et al., 2018	Netherlands	BD II	RPA self-focus subscale	Rumination on positive affect	27	8.78 (2.81)	175	7.23 (3.15)	—	—	mix	mix	>0.70
Kearns et al., 2016	Australia	mix	RRS total score	Depressive rumination	20	50.60 (15.0)	182	52.61 (11.7)	—	—	mix	mix	>0.70
Kim et al., 2012	South Korea	mix	RRS total score	Depressive rumination	54	61.94 (13.6)	227	54.21 (13.1)	—	—	mix	not reported	not reported
Liu et al., 2009	USA	not reported	RSQ rumination subscale	Depressive rumination	84	44.38 (12.6)	139	44.97 (13.2)	112	28.00 (4.00)	mix	mix	>0.70
Taylor Tavares et al., 2007	United Kingdom	BD II	RSQ rumination subscale	Depressive rumination	17	26.70 (5.03)	22	30.20 (4.97)	25	14.20 (4.1)	depressed	depressed	not reported
Weinstock et al., 2018	USA	BD I	RPA emotion focus subscale	Rumination on positive affect	30	14.20 (3.20)	30	12.00 (3.20)	30	2.80 (3.10)	depressed	depressed	>0.70
Weinstock et al., 2018	USA	BD I	RPA self-focus subscale	Rumination on positive affect	30	9.50 (2.80)	30	8.40 (2.70)	30	12.20 (3.30)	depressed	depressed	>0.70
Weinstock et al., 2018	USA	BD I	RRS brooding subscale	Depressive rumination	30	11.10 (3.10)	30	10.00 (3.00)	30	8.60 (2.90)	depressed	depressed	>0.70

(*continued on next page*)

Table 1 (*continued*)

Study name	Country	BD group diagnosis	Rumination scale	Rumination subtype	Rumination score						Current BD episode	Current MDD episode	Rumination scale reliability
					BD		MDD		HC				
					n	M (SD)	n	M (SD)	n	M (SD)			
Wolkenstein et al., 2014	Germany	mix	CERQ rumination subscale	Rumination NOS	42	11.36 (3.79)	43	12.16 (3.55)	39	7.21 (2.71)	remitted/ euthymic	remitted	not reported
Yavuz et al., 2016	Turkey	not reported	RTSQ total score	Rumination NOS	35	97.66 (23.3)	168	77.83 (23.4)	—	—	not reported	not reported	not reported

Note. LESS = Leahy Emotional Schema Scale; CERQ = Cognitive Emotion Regulation Questionnaire; RPA = Responses to Positive Affect; RSQ = Response Style Questionnaire; RRS = Ruminative Response Scale; RTSQ = Ruminative Thought Style Questionnaire; NOS = not otherwise specified.

A coding sheet was created to extract descriptive statistics regarding the sample and study procedures, and quantitative information about the rumination measures in order to compute effect sizes from each study. It is also important to examine how much the two groups differ in terms of clinical and demographic factors, as such inequalities may serve as confounds. More specifically, the coded variables were the rumination measure and the subscale, rumination subtype (depressive rumination/rumination on positive affect/reflection/rumination not further specified), continent and country (according to the place of data collection), publication year, sample size, gender and age data for both patient groups (% of female participants), diagnosis of BD sample (BD-I/BD-II/mix/not reported), current episode of BD participants (depression/mania/euthymic/mix/not reported), and current mood status of MDD participants (depressed/remitted/mix/not reported). We also extracted data regarding the methodological quality of the articles: we registered whether the articles reported the reliability of the rumination measure, whether the two groups had normally distributed scores on the rumination measure, whether any calculations were done for statistical power, and whether the patients groups were matched in the primary studies. We also aimed to compare the two patient groups regarding years with the disorder, ongoing psychotherapy and pharmacotherapy, and dropout rates. However, these characteristics were scarcely or heterogeneously reported, thus could not be evaluated systematically.

Every article was coded by two researchers independently. Acceptable agreement was found between the coders on categorical variables. Interrater reliability was high regarding the outcome measure (e.g. type of rumination, rumination score, rumination scale reliability) ranging from 90.48% to 100%, whereas it ranged from acceptable (e.g. gender data 76.15%) to high (e.g. BD subtype diagnosis 100%) in terms of demographic data and descriptive statistics. Coders resolved any disagreements by discussion. Based on the recommendations of Ma et al. (2020), we used the Joanna Briggs Institute's (JBI) critical appraisal tool for cross-sectional studies to estimate the risk of bias by assessing the methodological quality of the primary papers (Moona et al., 2017). It comprises of eight items that could be answered with “yes”, “no”, “unclear” or “not applicable (n/a)”. Each primary article was evaluated independently by two of the authors (L.N.K & Zs.T) with 84.5% agreement. The authors resolved the discrepancies by involving the last author (Gy.K.). A total score was also calculated for each study, where every affirmative answer counted as one, any other answer scored as zero. Seven items were applicable for the current studies, thus that was the highest possible score. The details of the risk of bias assessment are presented in Table 2.

2.4. Statistical analysis

We conducted the analyses with the Comprehensive Meta-Analysis (CMA) Version 3 (Borenstein et al., 2006). First, the effect size for each contrast for the standardized mean difference between the BD and the MDD patient groups on the rumination subscales were calculated, where the raw means and standard deviations of the rumination scores were used. A positive effect size indicated that the BD group was more prone to rumination in terms of the given rumination subtype, while a negative effect suggested that the MDD group reported more rumination. We used the effect size of Hedges's *g* that corrects for sample sizes (Borenstein et al., 2009). In studies that reported more than one rumination measure, the Hedges's *g* value of the study is the average of the Hedges's *g* values on each rumination scale, as these effect sizes are not considered independent. Studies with a standardized residual exceeding ± 3.29 were considered outliers (Tabachnick and Fidell, 2012).

We compared the two patient groups regarding gender ratio and mean age with *t*-tests using IBM SPSS Software Version 25.0 (IBM Corp., Armonk, NY). We conducted meta-regression analyses to assess the impact of potential confounds such as publication year, gender ratio of the BD and MDD group, mean age of the BD and MDD group, and the

Table 2
Quality assessment of the primary studies.

Study	JBI critical appraisal checklist 1 inclusion	2 study description	3 exposure	4 condition measurement	5 confounds identified	6 strategies for confounds	7 outcome measurement	8 statistical analysis	Total score
Batmaz et al., 2014	yes	yes	N/A	yes	yes	yes	yes	yes	7
Fletcher et al., 2013	yes	yes	N/A	yes	yes	yes	yes	yes	7
Forgeard et al., 2018	yes	yes	N/A	yes	yes	yes	yes	yes	7
Gilbert et al., 2013	yes	yes	N/A	yes	yes	yes	yes	yes	7
Hanssen et al., 2018	yes	yes	N/A	yes	yes	no	yes	yes	6
Kearns et al., 2016	yes	yes	N/A	yes	yes	yes	yes	yes	7
Kim et al., 2012	yes	yes	N/A	yes	yes	yes	yes	yes	7
Liu et al., 2009	yes	yes	N/A	yes	yes	yes	yes	yes	7
Taylor Tavares et al., 2007	yes	yes	N/A	yes	yes	yes	no	yes	6
Weinstock et al., 2018	yes	yes	N/A	yes	yes	yes	yes	yes	7
Wolkenstein et al., 2014	yes	yes	N/A	yes	yes	no	yes	yes	6
Yavuz et al., 2016	unclear	no	N/A	unclear	no	no	yes	yes	2

Note. Possible answers: Yes, No, Unclear or N/A (Not Applicable). Checklist Items: 1. Were the criteria for inclusion in the sample clearly defined?2. Were the study subjects and the setting described in detail? 3. Was the exposure measured in a valid and reliable way? 4. Were objective, standard criteria used for measurement of the condition? 5. Were confounding factors identified? 6. Were strategies to deal with confounding factors stated? 7. Were the outcomes measured in a valid and reliable way? 8. Was appropriate statistical analysis used?.
From: Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, Currie M, Qureshi R, Mattis P, Lisy K, Mu P-F. Chapter 7: Systematic reviews of etiology and risk . In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017.

total scores of the critical appraisal tool on the dependent variable. Then, we conducted five meta-analyses. We included all the rumination measures in the first average to see whether there is a significant difference between the ruminative tendencies of the two patient groups in general. In order to examine whether there are significant differences between the two groups according to the different subtypes of rumination, we conducted four additional meta-analyses, one for each subtype (depressive rumination / reflection / rumination on positive affect / rumination not further specified). The random-effects model using DerSimonian and Laird method was used to calculate the average effect sizes, which allows for between-study variance beyond sampling error (Borenstein et al., 2009). The heterogeneity of the effect was determined by the Q-statistics and the I^2 index, based on which we conducted additional analyses. First, we examined the contrasts where only BD-I patients were included in the study, followed by an analysis where only BD-II patients were included. Then, we examined the effect sizes according to the current mood state of BD and MDD patients. Publication bias was inspected using funnel plots. In case of significant average effect sizes, Rosenthal's fail-safe n was also calculated (Rothstein et al., 2005). Publication bias was assessed with the help of the Egger's test and funnel plots including Duval and Tweedie's trim-and-fill method (Duval and Tweedie, 2000; Egger et al., 1997).

3. Results

3.1. Descriptive information

Our literature review yielded 12 studies published in peer-reviewed journals that examined rumination among both MDD and BD patients, with an overall sample size of 2071 (n of BD patients = 671, n of MDD patients = 1400). BD sample sizes ranged from 17 to 140 (Mean = 55.92, SD = 36.04), MDD sample sizes ranged from 22 to 227 (Mean = 116.67, SD = 70.77). The mean sample age was 35.01 years (SD = 6.05) among BD patients, and 36.1 years (SD = 5.41) among MDD patients. The majority of both samples were female (% of $females_{BD}$ = 63.9%,% of $females_{MDD}$ = 67.28%). The 12 studies altogether contained 26 patient groups, 14 with bipolar and 12 with major depressive disorder, while six studies also assessed rumination among healthy controls (HC) (n = 447). Five studies recruited bipolar patients without specifying BD subtype, while six studies had homogenous BD samples, i.e. included either BD-I (k = 3), or BD-II (k = 1) patients only, while two studies had both a homogenous BD-I and a homogenous BD-II group. Information regarding BD subtype was missing in case of one study. Ten studies contained information regarding the current episode of BD patients: two studies recruited currently depressed BD patients, two studies reported currently euthymic BD patients, while six studies included BD patients regardless their current mood state. Eight studies reported the episode of MDD patients: two studies recruited currently depressed MDD patients, two studies recruited currently remitted MDD patients, while four studies included MDD patients who were either depressed or remitted. Eight studies described the reliability of the rumination scale(s) they used, and three studies reported a priori or post-hoc power calculations. The two patient groups were matched in one study, whereas in seven studies the groups were not matched, but it was tested whether the two groups differed significantly in terms of clinical and/or demographic factors, such as age and gender. The 6th item of the JBI critical appraisal checklist (Table 2) describes whether the revealed group differences were addressed. The remaining four studies did not report any information about potential confounding group differences.

3.2. Group differences in rumination

We assessed whether there were significant differences in age and the percentage of females between the MDD and BD groups by paired sample t-tests. We did not find any significant difference in terms of age (t = 0.727, p = 0.488), however, there was significant difference in female percentage (t = 2.615, p = 0.26), thus we calculated its group difference, and added it as a moderator for each study. Then we conducted meta-regressions to assess the impact of potential confound variables. We ran several models testing for the effect of publication year (β = 0.056, p = 0.11, k = 12), gender ratio of BD group (β = −1.76, p = 0.33, k = 9), gender ratio of MDD group (β = −1.53, p = 0.31, k = 9), difference in the percentage of females (β = −3.17, p = 0.27, k = 11), age of BD group (β = 0.003, p = 0.79, k = 9), age of MDD group (β = 0.002, p = 0.83, k = 9), and the JBI critical appraisal checklist score (β = −0.13, p = 0.07, k = 12). None of these moderators had a significant effect, however, the JBI checklist score demonstrated a tendency level effect due to the low score of one article, calling for further examination.

Then, we conducted a meta-analysis including all rumination measures, in order to test whether there was a significant difference between the ruminative tendencies of the two patient groups in general. The funnel plot (Fig. 1 of the Supplemental Material) did not indicate any publication bias. As Fig. 2 demonstrates, we did not find a significant difference between the two patient groups in terms of

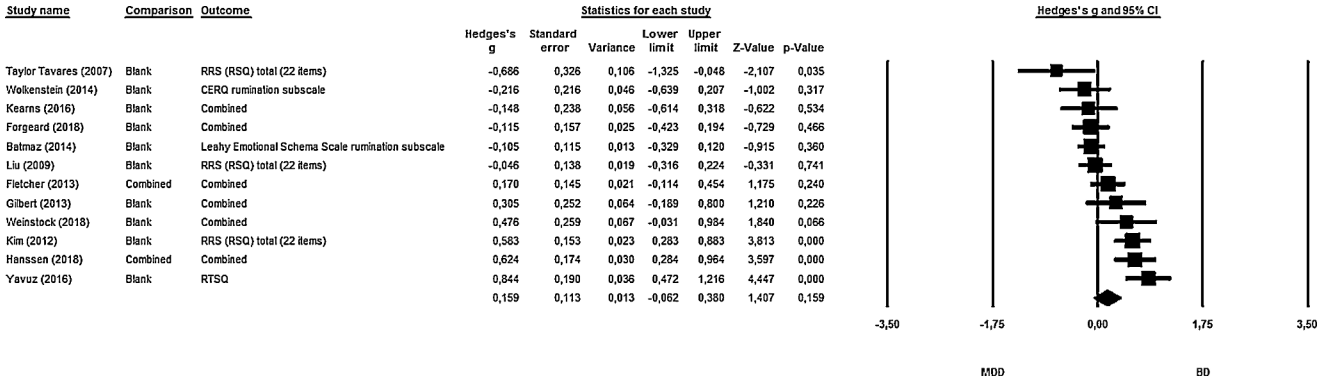

Fig. 2. Forest plot for rumination in BD compared to MDD.

Table 3
Meta-analyses according to rumination subtype.

		Effect size and 95% confidence interval					Heterogeneity				
Rumination subtype	k	Hedges's g	SE	CI	Z	p	Q	df	p	I^2	Fail-safe N
depressive rumination	7	0.03	0.13	−0.23- 0.30	0.26	0.80	22.11	6	<0.01	72.86	–
rumination on positive affect	4	0.46	0.10	0.28–0.65	4.88	<0.00	1.67	3	0.64	0.00	20
reflection	1	0.04	0.16	−0.27–0.35	0.27	0.79	0.00	0	1.00	0.00	–
rumination not otherwise specified	4	0.08	0.22	−0.36–0.51	0.34	0.74	23.37	3	<0.01	87.17	–

Note. Random models. Positive Hedges's g values indicate BD group mean > MDD group mean.

rumination in general (g = 0.16, k = 12, SE = 0.11, 95% CI [−0.06, 0.38], p = 0.16). Since one article performed weaker on the quality assessment, we also conducted the analysis after excluding it, which only resulted in minor change in the effect size (g = 0.09, k = 11, SE = 0.11, 95% CI [−0.11, 0.30], p = 0.354]), thus we decided to keep it. The effect found was heterogeneous (Q = 51.71, p < 0.01, I^2 = 78.73), supporting the need to assess possible moderators. Thus, we conducted four additional meta-analyses, one for each rumination subtype (depressive rumination, rumination on positive affect, reflection, rumination not further specified). The results are summarized in Table 3. The funnel plots including the Duval and Tweedie trim and fill method (Figs. 2–4 of the Supplemental Material) did not indicate publication bias when all studies were included (Egger's regression intercept = 0.33, p = 0.44), and neither for rumination on positive affect (Egger's regression intercept = 0.05, p = 0.49). However, they indicated publication bias for the analyses of depressive rumination (Egger's regression intercept = −2.15, p = 0.23) and rumination NOS (Egger's regression intercept = 4.15, p = 0.29). Since reflection was only assessed by one study, publication bias estimation was not applicable.

As hypothesized, we could not find significant difference between the two patient groups in terms of depressive rumination in the seven available studies. However, as expected, based on the four relevant studies the BD group reported more rumination on positive affect. Relying on Cohen's guidelines (Cohen, 1962), this was a moderate-sized difference. The results are demonstarted in Fig. 3. There was only one article that assessed reflection among the two patient groups, which did not find any significant difference. No significant differences were found between the BD and the MDD group on the NOS rumination scales either (the effect size altered marginally when excluding one study with ambiguous quality: g = −0.15, k = 3, SE = 0.08, 95% CI [−0.31, 0.12], p = 0.07]).

In order to check whether our non-significant results derive from the lack of statistical power or they truly indicate no differences between the two patient groups, we conducted a meta-analysis on the six studies that also assessed rumination on a HC sample besides the two patient groups. We calculated effect size for the difference between the HC group and the BD patients, where we expected the BD group to report significantly more rumination. We included all rumination subtypes in the analysis. The funnel plot (Figure 5 of the Supplemental Material) did not indicate any publication bias (Egger's regression intercept = 1.15, p = 0.37). The results revealed that the BD group reported more rumination with a large effect size (g = 1.39, k = 6, SE = 0.25, 95% CI [0.91, 1.87], p < 0.01). The fail-safe N was 356 which suggests a robust effect. The effect was heterogeneous (Q = 36.44, p < 0.01, I^2 = 86.28).

We could not find any significant difference between BD and MDD patients when all rumination subtypes were included in the analysis. However, a highly heterogeneous effect was found, thus we conducted additional analyses to further explore possible distinctions between the two patient groups. First, we tested for BD group diagnosis, and compared BD-I patients and BD-II patients to MDD patients separately, where we hypothesized that the difference in rumination would be more articulated between BD-I and MDD patients than between BD-II and MDD patients, given that BD-I patients tend to experience the most labile and severe affect states among these patient groups. We could only include articles that recruited homogenous BD patient groups, which resulted in a reduced number of studies and smaller statistical power. Nonetheless, we found tendency level difference between BD-I patients and MDD patients in terms of rumination, whereas we could not find any significant difference between BD-II and MDD patients. The results are summarized in Table 4.

Since the BD group reported more rumination on positive affect than the MDD group, we explored whether this difference remains significant when testing for the two BD subgroups separately. Albeit few studies could be included in these analyses too, our results support that both BD-I (g = 0.51, k = 4, SE = 0.086, 95% CI [0.34, 0.68], p < 0.01]) and BD-II patients (g = 0.44, k = 2, SE = 0.12, 95% CI [0.21, 0.67], p < 0.01) report more rumination on positive affect than MDD patients, with similar moderate effect sizes. The effect was homogenous in case of both BD-I (Q = 2.29, p = 0.52, I^2 < 0.01) and BD-II patients (Q = 0.95, p = 0.33, I^2 < 0.01). The funnel plots (Figure 6–7 of the Supplemental Material) did not indicate any publication bias. Egger's regression intercept was 2.03 (p = 0.31) and −3.15 (p = 0.33), respectively.

Moreover, we aimed to test whether the current mood state of MDD patients (depressed vs. remitted) and BD patients (depressed/manic/remitted) moderated the difference in rumination between the two

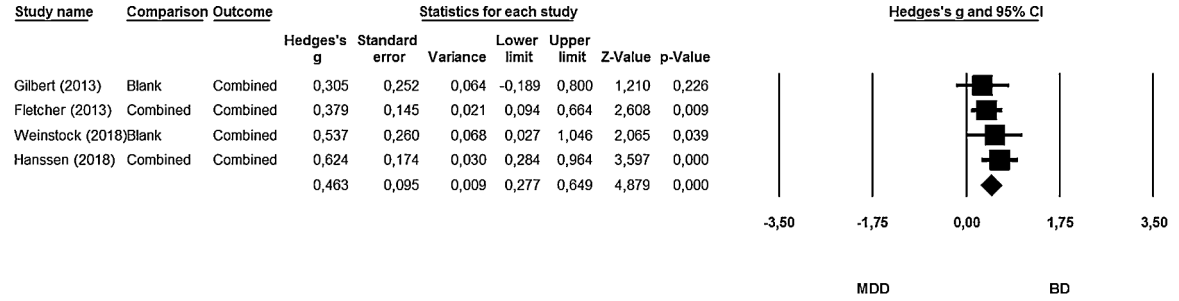

Fig. 3. Forest plot for rumination on positive affect in BD compared to MDD.

patient groups. Although the heterogeneity of effect sizes would favor such analyses, due to the fact that most of the studies ($k = 8$) did not delineate the current episode of patients, these moderation analyses could not be performed.

4. Discussion

A growing body of evidence indicates that mood disorders share numerous cognitive-emotional features in common, hampering their nosological categorization that is also reflected in the overlapping diagnostic categories of the DSM-5 (American Psychiatric Association, 2013; Zimmermann et al., 2009). The ongoing debate whether BD and MDD merely exhibit quantitative differences and shall be examined dimensionally, or they represent diverse neuropsychological features and should be considered distinct (Benazzi, 2006; Samamé et al., 2017) supports the need for studies that systematically compare cognitive-emotional features, such as rumination, in BD and MDD.

According to our knowledge, this is the first meta-analysis to compare rumination in BD and MDD. Twelve studies assessing rumination among both BD and MDD patients were found and reviewed. We did not find significant differences between the two patient groups on rumination in general. More specifically, however, while no differences appeared on depressive rumination, the BD group reported more rumination on positive affect, which remained significant when examining for BD-I and BD-II patient groups separately, with similar effect sizes. These findings suggest that both patient groups tend to engage in depressive rumination, whereas rumination on positive affect evidently mainly characterizes BD patients. The lower level of positive rumination in MDD may be due to the fact that these patients experience less positive emotions, or that they tend to ignore positive events and rather focus on their past negative experiences (Everaert et al., 2012). Moreover, research found that neural circuits associated with reward processing show heightened and prolonged activation patterns among BD patients (Phillips and Vieta, 2007). This is in line with the concept that BD patients tend to intensify and prolong positive emotions, which they often pursue by ruminating on positive affect, especially with a rewarding content, e.g. achievement (Gruber et al., 2011).

Additionally, when comparing BD-I and BD-II subgroups with the MDD group separately, a tendency-level effect size favoring BD-I patients was found for rumination in general. Our results also indicate that overall BD-I patients report slightly more rumination, which is plausible given that they experience both depressive and manic episodes to the greatest extent. When all rumination measures were included, such systematic difference could not be found between BD-II and MDD patients, suggesting that even if there was a slight difference favoring BD-II patients, the effect size is considerably smaller than in terms of the BD-I group. This is in line with recent functional magnetic resonance imaging (fMRI) studies, that demonstrated altered functioning in regions associated with emotion regulation among BD patients during task performance (Rey et al., 2014), as well as in resting state (Meda et al., 2012), suggesting irregular functionality involving the Default Mode Network (DMN) and areas associated with affect regulation processes (Rey et al., 2016).

Given its transdiagnostic nature, rumination appears to play an important role in numerous disorders, accounting for the co-occurrence of several symptoms (McLaughlin et al., 2014), especially when related to mood disturbances (Johnson et al., 2008). The excessive use of rumination characterizes both depression and mania (Townsend and Altshuler, 2012), thus synthetizing the empirical results about rumination in MDD and BD - where it has been studied less extensively - could yield important insights for future research. Furthermore, it appears that the ability to regulate intrusive, ruminative thoughts and broadening the repertoire of adaptive emotion regulation strategies (Berking et al., 2008) may help to prevent depressive (Nolen-Hoeksema and Aldao, 2011) and manic episodes (Johnson et al., 2008), thus a better understanding of how rumination might lead to affective disturbances in BD and MDD may foster the development of novel treatment strategies.

However, our study has certain limitations that should be considered when interpreting the results of this review. First and foremost, since we posited very specific questions in this paper, only a few studies qualified to be included in our analysis, resulting in a fairly reduced scope and applicability. On the other hand, this underlines that despite the ever-growing support to the continuum approach of mood disorders, there are still relatively few studies measuring emotion regulation strategies such as rumination both among BD and MDD individuals. It is also important to note that the small number of studies might have resulted in limited statistical power. Thus we conducted a meta-analysis on the six studies that assessed rumination on a HC sample besides the two patient groups. The BD group reported more rumination, suggesting that our non-significant results may not simply derive from the lack of statistical power, but rather indicate that there is no significant difference between the two patient groups in depressive rumination, reflection and ruminative tendencies in general. However, we would need more data for firm conclusions.

Second, we found heterogeneous effects in many of the executed analyses, possibly related to the diverse mood state of the patients in the primary studies. This also calls attention to an important issue of the

Table 4
Meta-analyses according to BD diagnosis.

		Effect size and 95% confidence interval					Heterogeneity				
BD diagnosis	k	Hedges's g	SE	CI	Z	p	Q	df	p	I^2	Fail-safe N
BD-I vs. MDD	5	0.28	0.17	−0.04- 0.60	1.69	0.09	19.96	4	<0.00	79.96	–
BD-II vs. MDD	3	0.09	0.29	−0.48–0.66	0.32	0.75	11.19	2	<0.00	82.13	–

Note. Random models. Positive Hedges's g values indicate BD subgroup mean > MDD group mean.

field: studies that assess emotion regulation in mood disorders often lack measuring and controlling for current affective episode, let alone current medication, years with the disorder, comorbidity or psychotherapeutic treatment, which makes the synthesis of the results difficult. Therefore, even though we wished to test for the moderating effect of these factors, especially the current episode of illness, the data gathered from the primary articles did not enable us to do so. Ideally, studies shall assess emotion regulation strategies in the whole spectrum of mood disorders prospectively, closely monitoring the changes in emotion regulation throughout the course of the illness, although designing such research is evidently challenging. Nonetheless, it is interesting that none of the included studies attempted to assess state rumination within these patient groups, i.e. the ruminative response given to a current mood state or stressor (LeMoult et al., 2013).

Hence, multiple questions remain unanswered, such as whether rumination on positive affect leads to, or simply accompanies elevated positive mood. One possibility is that rumination on positive affect leads to increased emotional reactivity and thus trigger symptoms of mania (Feldman et al., 2008). Although some results suggest that rumination may intensify not only negative, but positive affective states depending on the valence and content of the ruminative thought (Gilbert and Gruber, 2014), another study did not find any difference in the emotional or physiological response between BD patients and HCs to rumination induction (Gruber et al., 2011). Future research applying longitudinal, experimental or ecological momentary assessment design could shed light to the connection between current mood state and the momentary changes of emotion regulation strategies, which are particularly sought for concerning rumination on positive affect.

Moreover, while Egger's regression intercept was not significant for neither of our analyses, the Duval and Tweedie trim and fill method indicated publication bias in depressive rumination, suggesting that studies reporting more depressive rumination among BD patients than MDD patients are missing. This conveys that although the [hypo]manic pole of BD is more salient, it is important to keep in mind that BD patients also experience depressive symptoms and may ruminate on them to a similar, or perhaps even a bit greater extent than MDD patients. However, it is important to note that these publication bias methods would require more studies to obtain adequate statistical power, thus can only be interpreted cautiously (Sterne and Harbord, 2004).

Another important methodological issue is the quality of the original studies. 11 out of 12 studies got high quality scores, whereas one study was rated considerably weaker. This paper was included in the analyses of all rumination measures and rumination NOS only. Since the effect sizes differed negligibly when excluding this paper, and the lower performance of this article on the quality checklist may partially be due to its different focus compared to the other papers (i.e. the psychometric evaluation of a self-report scale in a clinical and non-clinical sample), we decided to keep it.

The fact that only self-report studies were included posits further limitations: for instance, recall biases play an articulated role in mood disorders (Tavares et al., 2003) that may decrease the validity of retrospective cross-sectional studies utilizing self-report measures. Also, while depressive rumination measures have been criticized for being biased by depressive symptoms (Smith and Alloy, 2009), the same question arises regarding the RPA: some of its items (e.g. “I am achieving everything”) appear to overlap with manic symptoms, while, on the other hand, its capability to capture the repetitive nature of such thoughts is arguable. Furthermore, the RPA instructs participants to indicate whether they think or do something “when feeling happy, excited, or enthused”. It would be interesting to explore whether BD patients they tend to recall their manic or remitted episodes when instructed to do so.

In summary, the findings of the current meta-analytic review suggest that rumination as assessed with self-report measures is present among both MDD and BD subjects, and that these patients may not differ in terms of depressive rumination, which they most probably experience during their depressive episodes. Rumination on positive affect mainly characterizes BD patients and appears to be linked with disturbed reward processing experienced in [hypo]mania. However, more studies are needed to be able to draw conclusions regarding the connection between current mood state/episode of illness and state rumination, which could also yield important insights about plausible interventions to reduce rumination in the different phases of mood disorders. Such interventions appear to have utmost importance in BD-I, as these patients experience the most severe affective symptoms in both directions, and therefore tend to ruminate the most.

Declaration of Competing Interest

The authors (*Lilla Nóra Kovács, Zsofia K. Takacs, Zsófia Tóth, Evelin Simon, Ágoston Schmelowszky, Gyöngyi Kökönyei*) declare that they do not have any interests that could constitute a real, potential or apparent conflict of interest with respect to her involvement in the publication. The authors also declare that they do not have any financial or other relations (e.g. directorship, consultancy or speaker fee) with companies, trade associations, unions or groups (including civic associations and public interest groups) that may gain or lose financially from the results or conclusions in the study. Sources of funding are acknowledged.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2020.07.131.

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