Journal of Affective Disorders 298 (2022) 577–589

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Personality traits as a risk factor for postpartum depression: A systematic review and meta-analysis

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ARTICLE INFO

Keywords:
Postpartum depression
Personality trait
Risk factor
Neuroticism

ABSTRACT

Background: Certain personality traits increase vulnerability to depression, but the evidence linking personality and postpartum depression (PPD) is less robust. This systematic review aimed to identify personality traits that increase the risk of PPD.

Methods: We systematically reviewed studies retrieved from PubMed/Medline, PsycINFO, Scopus, CINAHL, and Cochrane, following the PRISMA guidelines for reporting. We carried out a meta-analysis on the association between neuroticism and PPD.

Results: A total of 34 studies were analyzed. Of these, 31 considered at least one trait associated with PPD; 10 studies considered at least one trait not associated with PPD. The *meta-analysis* included 13 studies, concluding that neuroticism was associated with PPD (OR: 1.37; 95%CI: 1.22–1.53; $p<0.001$).

Limitations: Study design and approach to personality assessment influence results. Prospective longitudinal studies of persons with no prior history of mood disorder would provide stronger evidence about whether particular personality traits predict PPD. Most studies reviewed used self-report measures to assess personality. Study design and approach to personality assessment influence results, and indications of publication bias were found.

Conclusions: Neuroticism is the personality trait most widely studied in relation to PPD. Our meta-analysis found this trait is strongly related with PPD. Moreover, vulnerable personality style and trait anxiety are also associated with PPD. Screening for these traits might help identify women at risk, improving prevention, early detection, and possibly treatment.

1. Introduction

Women are especially vulnerable to psychiatric disorders during pregnancy and in the postpartum period, and mood disorders are the most common maternal psychiatric disorders after childbirth (Stocky and Lynch, 2000). Postpartum mood disorders are often classified into three categories, in order of increasing severity: blues, depression, and psychosis (O'Hara, 1986; Brockington, 2004). Postpartum depression (PPD) is usually defined as an episode of major depressive disorder (although minor depression is sometimes included) that occurs in the postpartum period (O'Hara and McCabe, 2013). Between 10% to 20% of women develop depression within a year of giving birth, and depressive symptoms persist beyond the first year in 25% of these (Falana and Carrington, 2019).

The vulnerability-stress model explains how different factors can affect susceptibility to psychopathologic disorders; predisposing factors are conceptualized as risk factors or protective factors, depending on whether they increase or decrease the likelihood that a stressor will lead to psychopathology (Grant and McMahon, 2008; Ingram and Luxton, 2005).

The etiology of PPD is not totally clear. Until recently, PPD was thought to be mainly due to biological changes after childbirth;

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https://doi.org/10.1016/j.jad.2021.11.010
Received 19 April 2021; Received in revised form 30 October 2021; Accepted 3 November 2021
Available online 8 November 2021

however, the predominant role of psychosocial factors in increasing the risk of developing PPD is now widely recognized. Risk factors for PPD can be divided into three main categories: psychosocial, clinical, and personality or temperamental features (Ambrosini et al., 2011). The main risk factors identified in systematic reviews are lower socioeconomic class, life stress during pregnancy, difficult pregnancy, marital dysfunction, poor social support, and a personal history of psychopathology (O'Hara and Swain, 1996; Robertson et al., 2004).

To identify personality traits that increase vulnerability to PPD, researchers must decide which personality trait or traits to examine and which instrument to use to assess vulnerability (Boyce et al., 2001). Despite this, there is conceptual overlap between clinical depression and personality traits as measured by the studies. Certain personality traits increase vulnerability to depression (Akiskal, 1983; Hirschfeld, 1999), and various of these have been proposed as risk factors for PPD, including dependency (Hirschfeld, 1983; Birtchnell, 1984), neuroticism (Coppen and Metcalfe, 1965, ; Duberstein et al., 2008, ; Lamers et al., 2012), obsessionality (Allsopp and Williams, 1991), perfectionism (Kawamura, 2001; Wei et al., 2014) and interpersonal sensitivity (Boyce, 1996). The link between personality traits and vulnerability to depression is well established (Mulder, 2002), but the findings linking personality and PPD are inconsistent and less robust.

Determining factors that increase the likelihood of developing PPD would help identify women at risk, improving efforts at prevention and early detection. This systematic review aimed to synthesize the findings in the growing body of literature exploring which personality traits, if any, are associated with PPD.

2. Methods

2.1. Transparency

The inclusion criteria and methods of analysis were specified in advance, and the protocol was registered on PROSPERO (Protocol number: CRD42020157523). We followed the PRISMA guidelines (Liberati et al., 2009) for reporting this systematic review.

2.2. Sources and search strategy

To identify relevant articles, we searched the PubMed/Medline, PsycINFO, Scopus, CINAHL, and Cochrane databases for articles published between 1990 and December 2020 for the terms "postpartum depression", "postnatal depression", "personality", "personality traits", and "women" with Boolean connectors (AND, NOT, OR). We used different strategies to search within each database; we will be happy to provide the full search strategy for each database upon request. As an example, the Medline search algorithm was ("depression, postpartum"[MeSH Terms] OR "postpartum depression" OR "postnatal depression") AND ("personality"[MeSH Terms] OR "personality").

The search was completed in December 2020; it was re-run just before the final analyses, and studies not identified in previous searches were retrieved for inclusion.

2.3. Criteria for study selection

To be included, articles were required to: (a) quantitatively examine the relationship between PPD (up to 12 months after delivery) and at least one personality trait (characteristic patterns of thoughts, feelings, and behaviors that are consistent and stable) using standardized questionnaires, inventories, or scales with published psychometric properties. Personality traits have been included according to their conceptual definition, regardless of the questionnaires used to assess them (b) present the results of cross-sectional, cohort, or case-control studies; (c) be published in the period comprising January 1990 through December 2020; (d) exclude participants with personality disorders and (e) be available in English.

If insufficient information was available to determine whether the study reported in the article met the inclusion criteria, we attempted to contact the corresponding author and/or publisher; in the absence of confirmation, the article was excluded. We also excluded studies whose reported effect size cannot be converted to odds ratios (OR). Studies without multivariable analysis were excluded.

2.4. Study selection

We used dedicated systematic review software (Covidence; Melbourne, Australia) (Babineau, 2014) to retrieve the references selected in the searches and automatically remove duplicates. Two independent researchers (MP and EG) examined the consistency of the search and suitable of studies in light of the inclusion and exclusion criteria. All Title, abstract and full text screening were conducted by both researchers. Disagreement was resolved through discussion, until consensus was reached.

The full texts of all articles deemed relevant were downloaded and examined to determine whether they met the inclusion criteria and to remove duplicates that might have been missed in the automated screening.

2.5. Data collection process and data items

Studies which met all inclusion criteria were reviewed by both researchers (MP and EG), extracting the year of publication, sample size, population characteristics, procedure, statistical analyses, and main findings from each paper and recording it in an Excel spreadsheet designed by researchers. Discrepancies in data extraction were resolved through discussion.

2.6. Assessment of study quality and risk of bias

The Newcastle-Ottawa Quality Assessment Scale (NOS) was used by both researchers (MP and EG) to evaluate the methodological quality of studies based on three aspects: selection of study groups, comparability of study groups, and ascertainment of either the exposure of interest in case-control studies or outcome of interest in cohort studies (Wells, 2015). Any discrepancies between the authors were resolved through discussion. We used the NOS to code the risk of bias in the results each study on a 10-point scale (0–9, where scores 0–5 indicate high risk of bias and scores 6–9 indicate low risk of bias). We excluded studies with scores <5 (Adejuwon et al., 2018; Denis and Luminet, 2018; Dudley et al., 2001; Gourounti, 2015 and Vliegen et al., 2006). Table 1 reports the quality score for each study included in this systematic review.

2.7. Data analysis

First, we analyzed the studies included in the review qualitatively to determine whether sufficient data were available to allow a meta-analysis of the relationship between any personality trait(s) and PPD. On finding that sufficient data were available for the trait neuroticism, we used a random effects model to calculate the magnitude of the mean effect and its 95% confidence interval in the 13 studies evaluating this trait as a risk factor for developing PPD. Importantly, some of these 13 studies report various OR because they assessed PPD at more than one timepoint. We excluded OR corresponding to measurements obtained in the immediate postpartum period (to avoid confusion with postpartum blues) and included only those corresponding to measurements obtained later in the first postpartum trimester. If multiple models were reported, only the final model was included.

To combine effect estimates, we performed a random-effects meta-analysis using the DerSimonian and Laird approach. To estimate the heterogeneity among studies, we calculated the I-squared statistic and its p-value. Results of the meta-analysis were plotted in a forest plot.

To explore which features of the studies were statistically associated

Table 1
Main characteristics of the studies included in the systematic review.

Author, Year	Country	Design	N	Depression measure/s	Assessment timepoint/ sDepression	Personality measure/s	Assessment timepoint/s Personality	Risk of bias
Axfors et al., 2017	Sweden	Cohort	1618	EPDS ≥12	Pregnancy, 6 weeks and 6 months PP	SSP. STAI-trait	Pregnancy	7
Besser et al. 2007	Israel	Cohort	209	CES-*D* ≥ 16	Pregnancy and 8 weeks PP	DEQ	Pregnancy	7
Besser and Priel 2003	Israel	Cohort	146	CES-D	Pregnancy and 8 weeks PP	DEQ	Pregnancy	7
Boyce et al., 2001	Australia	Cohort	717	EPDS >12, SCID-I	2 days PP and 6, 12, 18 and 24 weeks PP	VPSQ	2 days PP	7
Boyce and Hichey 2005	Australia	Cohort	425	EPDS >12, SCID-I	2 days PP and 6,12, 18 and 24 weeks PP	VPSQ	2 days PP	7
Boyce et al., 1991	Australia	Cohort	140	EPDS ≥13, BDI ≥11	Pregnancy, 1, 3, 6 month PP	EPI, IPSM	Pregnancy	7
Chang et al., 2014	Taiwan	Cross-sectional	213	CES-D	PP	MPI	PP	8
De Venter et al. 2015	Belgium	Cohort	187	EPDS ≥13	12 and 24 weeks PP	DS-14	Pregnancy	7
Dennis et al., 2004	Canada	Cohort	594	EPDS > 9	1 week PP	VPSQ	1 week PP	7
Fisher et al., 2002	Australia	Cross-sectional	109	EPDS, POMS	PP	VPSQ	PP	7
Gelabert et al., 2011	Spain	Cohort	309	EPDS ≥10, DIGS	8 and 32 weeks PP	VPSQ, EPQ-RS, FMPS, TCI	2–3 day PP	7
Gelabert et al., 2012	Spain	Case-control	237	EPDS ≥10, SCID-I	PP	FMPS, EPQ-RS	PP	8
Gonidakis et al., 2008	Greece	Cohort	402	EPDS ≥12, BQ, MADRS	First week PP and 1, 3, 6 months PP	STAI-Trait. SSPS, MOCI, WI	1 day PP	7
Grant et al., 2008	Australia	Cohort	100	EPDS: Antenatal ≥13, PP ≥10, MINI	Pregnancy and 32 weeks PP	STAI-Trait	Pregnancy and 32 weeks PP	7
Hipwell et al., 2004	United Kingdom	Cohort	94	EPDS ≥12.5, BDI >12, DSC	7–10 days PP and T3: 2 months PP	EPQ	Pregnancy	7
Iliadis et al., 2015	Sweden	Cohort	137	EPDS: Antenatal ≥13, PP≥12, DSRS	Pregnancy and 6 weeks and 6 months PP	SSP	Pregnancy and 6 months PP	7
Imsiragic et al. 2014	Croatia	Cohort	262	EPDS ≥9	3–5 days and 6–9 weeks PP	NEO-FFI	3–5 days and 6–9 weeks PP	7
Johnstone et al., 2001	Australia	Cohort	490	EPDS >12	8 weeks PP	VPSQS, SCID-II	1 week PP	7
Maia et al., 2012	Portugal	Cohort	386	BDI-II, DIGS	Pregnancy and 3 months PP	MPS	Pregnancy	7
Maliszewska et al., 2017a	Poland	Cross-sectional	387	EPDS >12 or item 10+, PHQ-9	4–8 weeks PP	NEO-FFI	PP	8
Maliszewska et al., 2016a	Poland	Cross-sectional	101	EPDS ≥13	First week PP	NEO-FFI	First week PP	8
Maliszewska et al., 2017b	Poland	Cross-sectional	548	EPDS ≥13, PHQ-9	First week and 3 months PP	NEO-FFI	First week PP	8
Maliszewska et al., 2016b	Poland	Cross-sectional	546	EPDS ≥13, PHQ-9	First week PP	NEO-FFI	First week PP	8
Marín-Morales et al., 2014	Spain	Cohort	116	EPDS, SCL-90-R	pregnancy and four months PP	NEO-FFI	Pregnancy	7
Martín-Santos et al., 2012	Spain	Cohort	1804	EPDS>9, DIGS	2–3 days, 8 and 32 weeks PP	EPQ-RS	2–3 days PP	7
Masih et al., 2007	Australia	Cohort	76	EPDS ≥13, BDI	Pregnancy and 8 weeks PP.	PSI-II	Pregnancy-and 8 weeks PP	7
Meltzer-Brody et al., 2013	Netherland	Cohort	682	EPDS retrospectively ≥12, CIDI	4 years follow up	NEO-FFI	Baseline	7
Phillips et al., 2010	Australia	Cross-sectional	157	EPDS, SCID-I	PP <12 months	VPSQS	PP <12 months	8
Priel and Besser 1999	Israel	Cohort	73	CES-D	Pregnancy and 8 weeks PP	DEQ	Pregnancy	7
Saisto et al., 2001	Finland	Cohort	211	BDI-II	Early pregnancy and late pregnancy and 2–3 months PP	NEO-PI	Pregnancy	7
Tian et al., 2012	China	Case-control	4567	EPDS, CIDI	PP	EPQ. NEO-FFI	PP	8
Van Bussel et al. 2009	Belgium	Cohort	403	EPDS, HADS-R	Pregnancy and 8–12 weeks and 20–25 weeks PP	NEO-FFI	Pregnancy	7
Verkerk et al., 2005	Netherland	Cohort	277	EPDS >11, RDC	Pregnancy and 3, 6, and 12 months PP	DPQ	Pregnancy	7
Vliegen and Luyten 2009	Belgium	Case-control	92	BDI	PP	DEQ	PP	8

EPDS, Edinburgh Postnatal Depression Scale; BDI, Beck Depression Inventory; DIGS, Diagnostic Interview for Genetic Studies; PHQ-9, Patient Health Questionnaire-9; POMS, Profile of Mood States Questionnaire; BQ, Kennerley's Blues Questionnaire; MADRS, Montgomery Asberg Depression rating scale; MINI, Mini International Neuropsychiatric Interview; DSRS, Depression Self-.
Rating Scale; SCL-90-R, Symptom Checklist-90 Revised CIDI, Composite International Diagnostic Interview; SCID-I, Structured Clinical Interview for DSM Axis I; CES-D, Radloff's Center for Epidemiological Studies – Depression scale; HADS-R, Hospital Anxiety and Depression Scale; RDC, Research Diagnostic Criteria; PP, postpartum; MPS, Multidimensional Personality Questionnaire; NEO-FFI, NEO Five-Factor Inventory; EPQ, Eysenck Personality Questionnaire; PSI-II, The Personality Style Inventory-Revised; VPSQS, Vulnerable Personality Style.

Questionnaire; DEQ, Depressive Experiences Questionnaire; NEO-PI, Neo Personality Inventory; DPQ, Dutch Personality Questionnaire; DEQ, The Depressive Experiences Questionnaire; SSP, Karolinska Scales of Personality; STAI-trait, State-Trait Anxiety Inventory; EPI, Eysenck Personality Inventory; IPSM, Interpersonal Sensitivity Measure; MPI, Maudsley Personality Inventory; DS-14, Standard Assessment of Negative Affectivity, Social Inhibition, and Type D Personality; TCI, Temperament and Character Inventory; FMPS, Frost Multidimensional Perfectionism Scale; MOCI, Maudsley Obsessive-Compulsive Inventory; SCID-II; Structured Clinical Interview for DSM Axis II; PP, postpartum.

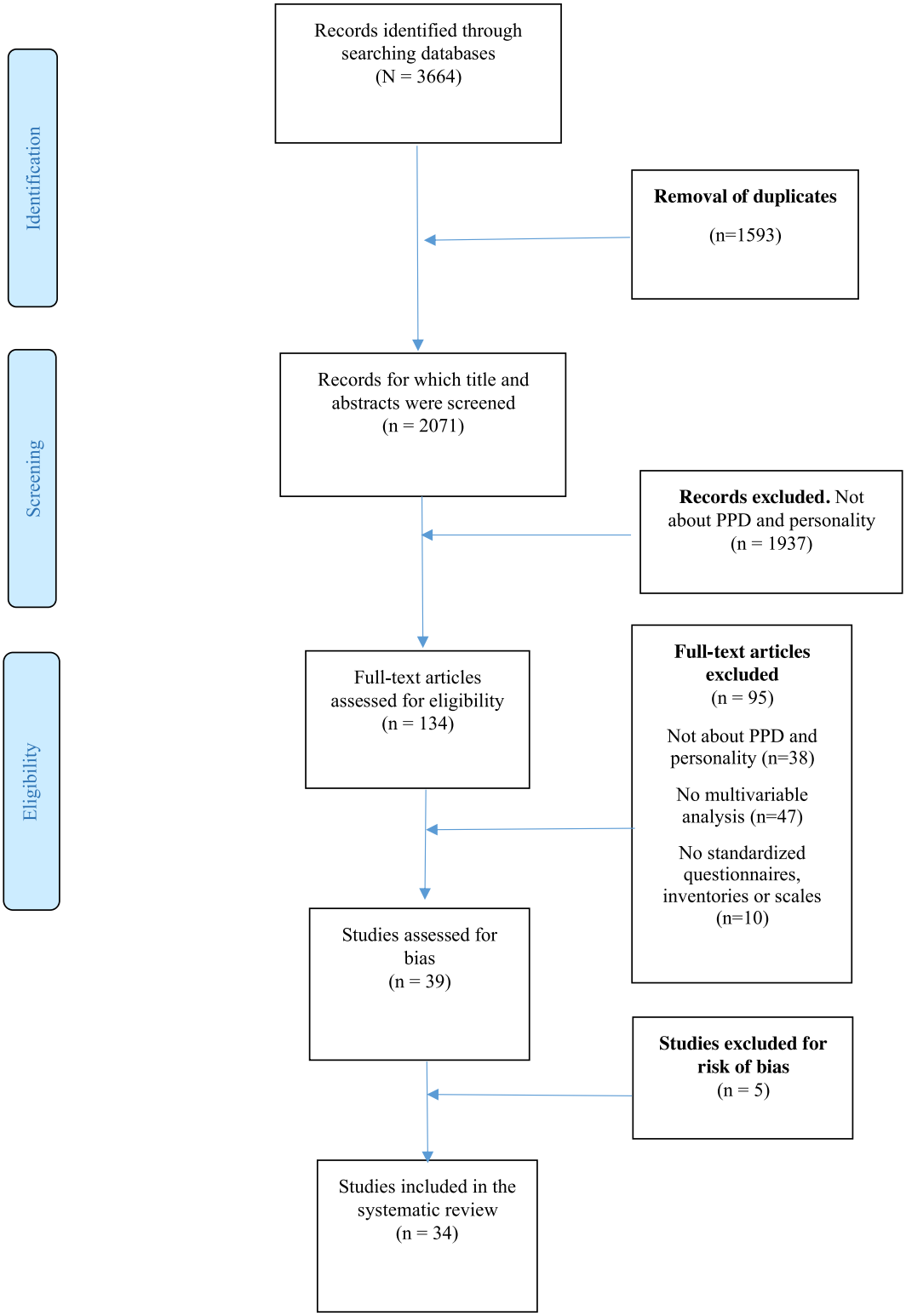

Fig. 1. Flowchart for study selection.

with the magnitudes of the effect, first we fit a bivariate meta-regression model assuming mixed effects for each of the characteristics, where the outcome variable was the effect estimate (log odds ratio) and the explanatory variables were characteristics of studies that might influence the size of effect. Finally, we fit a multiple meta-regression model assuming mixed effects including the most relevant features that explained some of the variability in the magnitude of the effect observed in the bivariate study. These features are: study design (Cohort vs Case-control), country (Europe Nordic countries vs Europe except Nordic countries), Timepoint(s) of personality assessment (Pregnancy vs Postpartum), Edinburgh Postnatal Depression Scale cutoff (<12 vs ≥ 12), diagnostic approach of PPD (Diagnoses vs Symptomatology), timepoint (s) of depression assessment (1 week after birth vs 6–8 weeks after birth, 1 week after birth vs 24 weeks of 1 year after birth) and type of variable to assess neuroticism (Categorical variable vs Continuous variable).

To analyze small-study effects, we used a funnel plot and the Egger test, representing the 13 magnitudes of the effect (OR) against its standard errors. Lastly, we performed a sensitivity analysis, repeating the meta-analysis 13 times, as many times as individual studies, excluding one study each time. We used Stata statistical software version 16.1 for all analyses.

3. Results

The PRISMA flow diagram in Fig. 1 summarizes the study selection process. The initial search yielded 3664 articles. After duplicates were excluded, the titles and abstracts of 2071 studies were screened, leaving 133 to be screened through full text. Of these, 99 were excluded; thus, the final sample consisted of 34 studies.

3.1. Characteristics of the studies included in the review

Table 1 presents the main characteristics of the studies included in this systematic review. They were conducted in 15 different countries in Europe, North America, Asia, and Oceania; most were done in Europe ($n = 10$).

The most common type of study was cohort studies ($n = 24$), followed by cross-sectional studies ($n = 7$) and case-control studies ($n = 3$). Most studies recruited women at hospitals and maternity clinics. Sample size ranged from 73 to 4567 subjects.

All studies used screening tools to detect PPD, mainly the Edinburgh Postnatal Depression Scale (EPDS) (Cox, 1987), used in 27 studies; 8 studies also used clinical interviews to diagnose PPD according to ICD-10 or DSM-IV criteria. The timepoints at which PPD was assessed varied widely among studies. Most studies ($n = 22$) assessed PPD more than once.

Diverse tools were used to assess personality, the most commonly employed being the Neo Five Factor Inventory (NEO-FFI) (Costa and Mc Crae, 1992) ($n = 9$). Most studies assessed personality only once ($n = 30$), usually between the second and third trimesters of pregnancy; however, the timepoints at which personality was assessed varied widely. The studies analyzed different personality traits, most commonly neuroticism ($n = 18$) and extraversion ($n = 10$).

3.2. Association between personality and postpartum depression

Most studies ($n = 31$) found associations between some personality traits and PPD, thus concluding that the associated traits should be considered risk factors. Some studies ($n = 10$) found no association between certain personality traits and PPD, thus concluding that these traits should not be considered risk factors.

Table 2 summarizes the 10 studies that found no association between personality traits and PPD. As seen in Table 1, 7 of these were longitudinal (cohort) studies and 3 were cross-sectional studies. All used screening tools; the EPDS was used in 9 studies, with cutoffs for PPD ranging from 9 to 13. One study (Masih et al., 2007) also used the BDI to

Table 2
Results of studies affirming that certain personality trait is not associated with postpartum depression.

Author, year	Depression assessment timepoint (after delivery)	Personality trait	β	*p*	R^2	*p*	Adjusted OR (95% CI)	*p*
1. De Venter et al. (2015)	12 weeks	Type D personality	–	–	–	–	2.22 (0.66–7.48)	ns
	24 weeks	Type D personality	–	–	–	–	2.49 (0.73–8.50)	ns
2. Imsiragic et al. (2014)	3–5 days	Extraversion	–	–	–	–	0.95 (0.88–1.03)	ns
	3–5 days	Agreeableness	–	–	–	–	1.04 (0.97–1.12)	ns
	3–5 days	Conscientiousness	–	–	–	–	0.97(0.90–1.04)	ns
	3–5 days	Openness to experience	–	–	–	–	0.98(0.93–1–04)	ns
	6–9 weeks	Extraversion	–	–	–	–	1.05(0.95–1.15)	ns
	6–9 weeks	Agreeableness	–	–	–	–	0.94(0.86–1.03)	ns
	6–9 weeks	Conscientiousness	–	–	–	–	0.97(0.89–1.06)	ns
	6–9 weeks	Neuroticism	–	–	–	–	1.07(0.96–1.20)	ns
3. Maia et al. (2012)	12 weeks	Perfectionism.- Self-oriented	0.005	ns	–	–	1.005 (0.980–1.032)	ns
		Perfectionism.-Other's high standards	0.016	ns	–	–	1.016 (0.979–1.054)	ns
		Perfectionism.- Conditional acceptance	0.003	ns	–	–	1.003 (0.947–1.063)	ns
4. Maliszewska et al. (2017a)	4–8 weeks	Extroversion	–	–	–	–	0.96 (0.75–1.22)	ns
		Openness to experience	–	–	–	–	0.86 (0.69–1.07)	ns
		Agreeableness	–	–	–	–	1.03 (0.84–1.26)	ns
		Conscientiousness	–	–	–	–	0.89 (0.72–1.10)	ns
5. Maliszewska et al. (2016a)	First week	Neuroticism	–	–	–	–	1.89 (0.94–3.81)	ns
6. Marín-Morales et al. (2014)	16 weeks	Extroversion	−0.104	ns	–	–	–	–
		Conscientiousness	−0.086	ns	–	–	–	–
7. Masih et al. (2007)	8 weeks	Autonomy personality	0.20	–	0.321	ns	–	–
8. Meltzer-Brody et al. (2013)	4 years	Extraversion	–	–	–	ns	–	–
9. Phillips et al. (2010)	<12 months	Vulnerable personality	0.10	ns	–	–	–	–
10. Van Bussel et al. (2009)	20–25 weeks	Agreeableness	−0.02	ns	–	–	–	–
	20–25 weeks	Conscientiousness	0.17	ns	–	–	–	–
	20–25 weeks	Extroversion	−0.09	ns	–	–	–	–

evaluate symptoms of PPD, and another (Maia et al., 2012) used the BDI but not the EPDS. The timepoints for PPD assessment ranged from the immediate postpartum to four years after delivery.

The traits that were not considered risk factors for PPD in these studies were extraversion (Imsiragic et al., 2014; Maliszewska et al., 2017a; Marín-Morales et al., 2014; Meltzer-Brody et al., 2013, and Van Bussel et al., 2009), neuroticism (Imsiragic et al., 2014 and Maliszewska et al., 2016a) perfectionism (Maia et al., 2012), and vulnerable personality (Phillips et al., 2010).

Table 3 summarizes the 31 studies that found an association between one or more personality traits and PPD; 22 of these were cohort studies ($n = 22$). As seen in *Table 1*, all used screening tools; the EPDS was used in 25. In addition to screening tools, 8 studies (Boyce et al., 2001; Boyce and Hichey., 2005; Gelabert et al., 2011, 2012; Grant et al., 2008; Martín-Santos et al., 2012; Meltzer-Brody et al., 2013; Tian et al., 2012) used clinical interviews to confirm the diagnosis of PPD according to

Table 3
Results from studies affirmed that certain personality trait is associated with PPD.

Author, year	Depression assessment timepoint (after delivery)	Personality trait	β	*p*	R^2	*p*	Adjusted OR (95% CI)	*p*
1. Axfords et al. (2017)	6 months	Neuroticism	–	–	–	–	5.44 (2.77–10.69)	<0.001
		Anxiety trait	–	–	–	–	3.42 (1.34–8.71)	<0.001
2. Besser et al. (2007)	8 weeks	Dependency	−0.19	<0.05	0.37	<0.001	–	–
		Self-criticism	0.43	<0.001	0.37	<0.001	–	–
		Self-criticism	0.36	<0.001	0.39	<0.01	–	–
3. Besser and Priel (2003)	8 weeks	Dependency	−0.22	<0.01	0.22	<0.001	–	–
		Self-criticism	0.20	<0.01	0.22	<0.001	–	–
4. Boyce et al. (2001)	24 weeks	Vulnerable personality	–	–	–	–	1.18 (1.10–1.20)	<0.001
		Organised/responsive	–	–	–	–	0.792 (0.66–0.94)	<0.001
5. Boyce and Hichey (2005)	24 weeks	Vulnerable personality	–	–	–	–	2.82 (1.06–7.45)	<0.001
		Organised/responsive	–	–	–	–	3.69 (1.26–10.84)	<0.001
6. Boyce et al. (1991)	24 weeks	Interpersonal sensitivity	0.29	<0.01	0.24	<0.001	2.90	<0.05
		Extraversion	−0.11	<0.01	0.19	<0.001	2.24	<0.05
		Neuroticism	0.10	<0.01	0.19	<0.001	0.69	<0.05
7. Chang et al. (2014)	1 year	Neuroticism	–	–	–	–	1.25 (1.17–1.34)	<0.001
8. Dennis et al. (2004)	1 week	Vulnerable personality	0.20	–	–	–	1.21 (1.13–1.31)	<0.001
9. Fisher et al. (2002)	postpartum	Vulnerable personality	–	–	–	–	1.2 (1.02–1.39)	<0.02
10. Gelabert et al. (2011)	32 weeks	Vulnerable personality	–	–	–	–	1.16 (1.07–1.26)	<0.001
11. Gelabert et al. (2012)	postpartum	Perfectionism	1.092	<0.05	–	–	2.98 (1.23–7.21)	<0.05
		Neuroticism	1.421	<0.01	–	–	4.14 (1.72–9.94)	<0.05
12. Goniadakis et al. (2008)	First week, 1, 3, 6 months	Obsessivity (cleaning)	0.3	<0.05	–	–		–
13. Grant et al. (2008)	32 weeks	Anxiety trait	1.81	<0.05	–	–	6.12 (1.37–27.41)	<0.05
14. Hipwell et al. (2004)	8 weeks	Neuroticism	0.25	<0.05	0.17	<0.001		–
Author, year	Assessment timepoint (after delivery)	Personality trait	β	*p*	R^2	*p*	Adjusted OR (95% CI)	*p*
15. Iliadis et al. (2015)	6 weeks	Neuroticism	–	–	–	–	5.0 (2.2–11.5)	<0.05
	24 weeks	Neuroticism	–	–	–	–	7.9 (3.1–20.0)	<0.05
16. Imsiragic et al. (2014)	3–5 days	Neuroticism	–	–	–	–	1.16 (1.07–1.25)	<0.05
	6–9 weeks	Openess	–	–	–	–	0.92 (0.86–0.99)	<0.05
17. Johnstone et al. (2001)	8 weeks	Vulnerable personality	–	–	–	–	7.54	<0.05
18. Maliszewska et al. (2017a)	4–8 weeks	Neuroticism	–	–	–	–	1.50 (1.17–1.92)	0.001
19. Maliszewska et al. (2016a)	First week	Extraversion	–	–	–	–	0.51(0.27–0.95)	0.04
20. Maliszewska et al. (2017b)	First week 3 months	Neuroticism	–	–	–	–	1.37 (1.05–1.77)	0.02
21. Maliszewska et al. (2016b)	First week	Neuroticism	–	–	–	–	1.65 (1.32–2.06)	<0.001
		Extraversion	–	–	–	–	0.77 (0.62–0.97)	<0.05
22. Marín-Morales et al. (2014)	16 week s	Neuroticism	0.42	–	0.247	<0.001	–	–
23. Martín-Santos et al. (2012)	8 weeks	Neuroticism	0.047	<0.001	–	–	1.05(1.02–1.07)	<0.05
	32 weeks	Neuroticism	0.040	0.021	–	–	1.04 (1.02–1.08)	<0.05
	32 weeks	Neuroticism	0.048	<0.001	–	–	1.05(1.02–1.08)	<0.05
24. Masih et al. (2007)	8 weeks	Sociotropic personality	0.25		0.42	<0.05	–	
25. Meltzer-Brody et al. (2013)	4 years follow up	Neuroticism	–	–	–	-		<0.05
26. Priel and Besser (1999)	8 weeks	Dependency	−0.24	<0.01	0.14	<0.01	–	–
		Self-criticism	0.41	<0.001	0.14	<0.01	–	–
27. Saisto et al. (2001)	8–12 weeks	Neuroticism	–	–	–	–	3.37 (1.04–10.86)	<0.05
28. Tian et al. (2012)	postpartum	Neuroticism	–	–	–	–	1.12 (1.09–1.21)	<0.05
29. Van Bussel et al. (2009)	12 weeks	Neuroticism	0.27	<0.001	0.12	<0.001	–	–
	20–25 weeks	Neuroticism	0.39	<0.001	0.23	<0.001	–	–
	20–25 weeks	Openess	0.28	<0.01	0.23	<0.001	–	–
30. Verkerk et al. (2005)	12 weeks	Neuroticism, Introversion	–	–	–	–	3.08 (1.10–8.63)	<0.05
	24 weeks	Neuroticism, Introversion	–	–	–	–	4.64 (1.65–13.16)	<0.01
	1 year	Neuroticism, Introversion	–	–	–	–	6.83 (1.97–23.74)	<0.01
31. Vliegen and Luyten (2009)	postpartum	Dependency	−0.11	–	0.09	<0.001	–	–
		Self-Criticism	0.03	–	0.09	<0.001	–	–
		Dependency and Self-Criticism	0.22	<0.01	0.05	<0.01	–	–

ICD-10 or DSM-IV criteria. The sample size was less than 400 women in 18 studies; Tian et al.'s (2012) case-control study included 4567 women.

The trait most commonly studied as a possible risk factor for PPD was neuroticism, analyzed in 18 (53%) of the studies; 17 (94%) of these found that neuroticism was a risk factor for PPD. However, the magnitude of the risk (OR) varied widely, ranging from 1.05 (95%CI: 1.02–1.07) in a convenience cohort (n = 1804) (Martin-Santos et al., 2012) to 7.90 (95%CI: 3.1–20.0) in a cohort (n = 137) of women screened for PPD (EPDS ≥ 12) 24 weeks postpartum (Iliadis et al., 2015). The vulnerable personality was analyzed in six studies, where ORs ranged from 1.16 (95%CI: 1.07–1.26) (Gelabert et al., 2011) to 2.82 (95%CI: 1.06–7.45) (Boyce and Hichey, 2005).

3.3. Meta-analysis of the studies that analyzed neuroticism associated with PPD

We performed a meta-analysis of the association between neuroticism and PPD (13 studies).

Our meta-analysis found this trait was associated with PPD (OR: 1.37; 95%CI: 1.22–1.53; p<0.001). However, given the great heterogeneity among the studies (I^2 = 88.3%; p <0.001), further analyses were necessary to clarify these results. This heterogeneity was confirmed with the forest plot (*Fig. 2*).

Therefore, given the great variability in the magnitude of the effect among the studies, we analyzed the characteristics of the studies to try to determine the source of this variability.

Among the characteristics of the studies analyzed, the country where the study was conducted (p = 0.084), the timing of the assessment of neuroticism (p <0.001), and the type of variable used to assess neuroticism (continuous or categorical) (p = 0.002) in bivariate analyses were the most important. These variables accounted for much of the variability in explained variance, with country explaining 37.64% of the variance, the type of variable used to assess neuroticism 84.69%, and the timing of the assessment of neuroticism 100% (*Appendix A*). Fitting a mixed-effects multiple meta-regression model revealed that the timing of the assessment of neuroticism explained 100% of the observed variance among the magnitudes of the effect (*Appendix B*). These results should be treated with caution since so that values are likely to be inflated R-squared values should be interpreted in light of the small sample size.

Fig. 3 plots the 13 magnitudes of the effect (OR) against their standard errors. The asymmetry in the magnitudes of the effects shown in these funnel plots was confirmed in the Egger test (p<0.001). Therefore, publication bias cannot be ruled out, because the tests for small-study effects indicate that smaller studies were more likely to present large effect sizes.

In the sensitivity analysis, the average effect size ranged from 1.30 to 1.51 and the heterogeneity ranged from 84.3% to 89.2%.

4. Discussion

We systematically analyzed studies published in the three last decades where the relationship between personality traits and PPD was investigated. Our analysis shows that discrepant findings are likely due mainly to differences in the timepoint(s) when personality traits and PPD were assessed, the approach used to diagnose PPD, and the personality trait under study. However, the design of these studies makes it impossible for us to determine causality in the relationship between personality and PPD. Moreover, studies researching the association between personality and depression often evaluate both constructs simultaneously. Although many of the cohort studies included here considered depressive symptoms as confounding factors, only one of them excluded women with concurrent depression at the time of personality assessment.

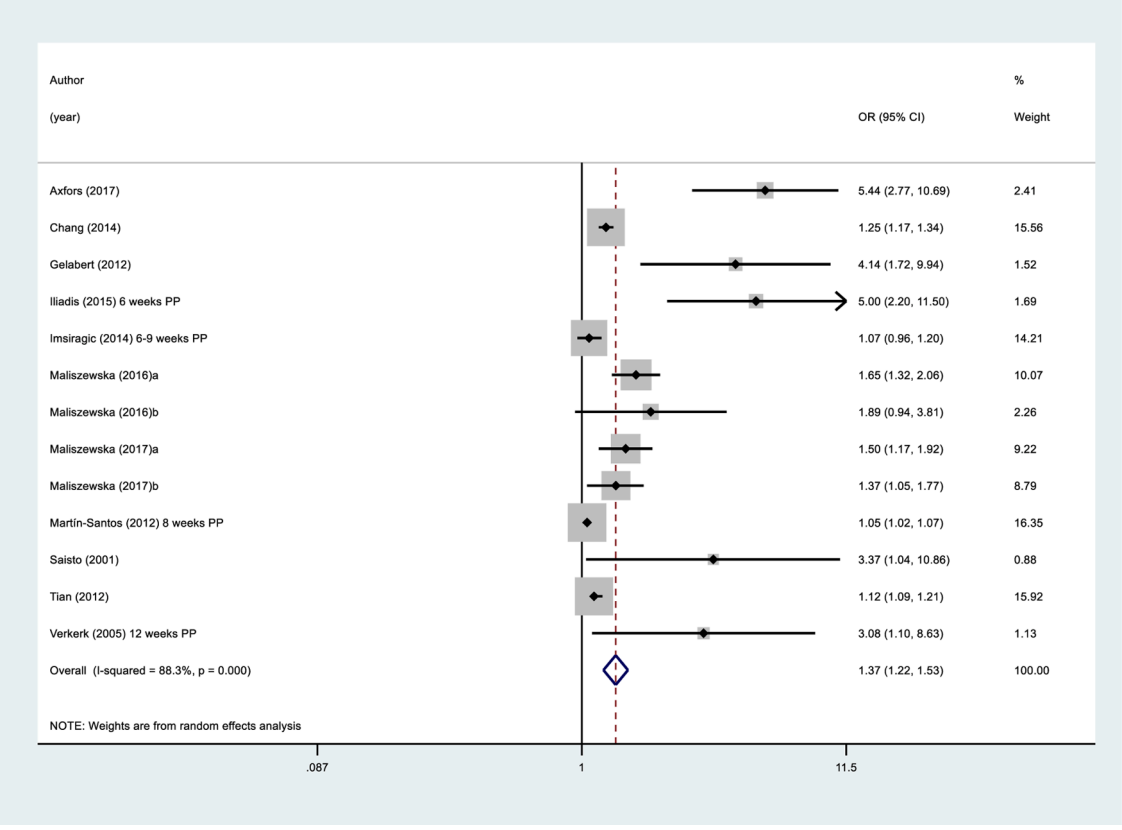

Fig. 2. Forest plot of the meta-analysis of random effects of neuroticism as a personality trait associated with postpartum depression.

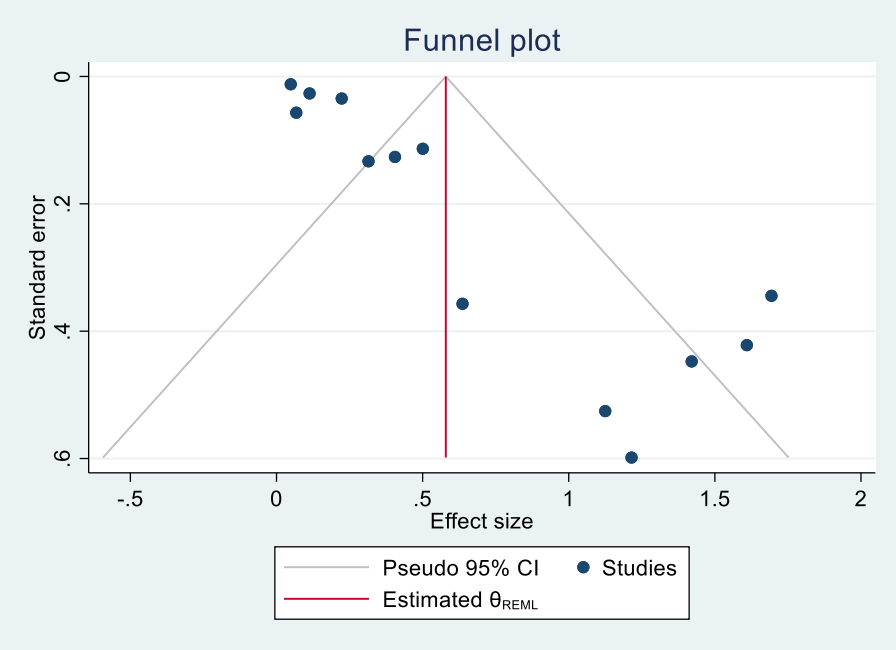

Fig. 3. Funnel plot showing the odds ratios of the 13 studies included in the meta-analysis of the effect of neuroticism as a personality trait associated with postpartum depression.

4.1. Time of assessment

The timepoint(s) when PPD and personality were assessed varied widely among studies. Taken together, these results reflect the progression of depressive symptoms during the postpartum period; however, the fact that PPD was assessed at different timepoints makes it difficult to compare studies and limits the generalizability of our findings.

In some of these, this assessment took place within days after childbirth (immediate postpartum). The results of these studies should be taken with caution, as depressive symptoms in this period may be indistinguishable from postpartum blues (O'Hara and Wisner, 2014).

It is important consider this aspect when interpreting the results. Depression is more common in the third trimester of pregnancy, when it is sometimes associated with delusional and suicidal thoughts. The onset of depression during pregnancy triples the risk of postpartum depression (Robertson et al., 2004)

In multiple studies, personality traits were assessed only in the postpartum period. Postpartum personality assessments can be distorted by depressive symptoms, whether related to PPD or to depression beginning prior to childbirth. Episodes of depression and residual effects can affect personality traits, and depressive states can modify scores for some personality traits such as neuroticism and extraversion (Griens et al., 2002). The effects of depression on personality assessments is problematic because there can be considerable overlap between personality construct and depression. Many of the studies included in this review did not take into consideration the fact that personality features can be state-dependent, so their results should be taken with caution.

4.2. Diagnostic approach: screening tests with or without clinical interviews

Whereas all studies included in the review assessed PPD through instruments that screen for depressive symptoms, only few of these (Boyce et al., 2001; Boyce and Hichey, 2005; Gelabert et al., 2011, 2012; Grant et al., 2008; Maia et al., 2012; Meltzer-Brody et al., 2013; and Phillips et al., 2010) also used clinical interviews (DSM, ICD) to assess the same subjects, thus increasing the validity of results. Screening tests are not diagnostic tests, and they might overestimate the prevalence of PPD.

4.3. Personality traits studied

The current study aimed to systematically review the evidence for personality traits as a risk factor for PPD. We found that a wide variety of traits had been explored; however, among the multitude of personality traits that could have been analyzed, most studies focused on very few traits. All the studies analyzed are vulnerable to selective analysis reporting and chance findings. Moreover, most report only significant associations, possibly disregarding null associations, so we cannot rule out a potential reporting bias at the study level. Thus, caution is warranted in interpreting the findings of any of the studies included in this review as well as those of the meta-analysis, which, taken together, may represent a selected sample of analyses.

Among the traits that have not aroused much interest in relation to PPD are sociotropic-autonomous personality, studied only by Masih et al. (2007), and Type D personality, studied only by De Venter et al. (2015). Likewise, only one study examined the relationship between obsessivity and PPD. Gonidakis et al. (2008) concluded that women obsessed with cleaning who feel that their baby cries excessively and had experienced stressful life events during pregnancy and prolonged maternity blues after delivery ran a higher risk of developing PPD during the first 6 months after delivery. These findings are in line with those reported in Russell's (2013) systematic review, which showed that obsessive-compulsive disorder often debuts or exacerbates during pregnancy.

Self-criticism and dependency were explored in three studies. Self-criticism refers to an excessive preoccupation with self-definition, control, and perfection; dependency refers mainly to fears about abandonment and loss. Two early studies carried out in Israel (Priel and Besser, 1999; Besser and Priel, 2003) found that self-criticism assessed during the third trimester of pregnancy predicted depressive symptoms 8 weeks postpartum in first-time mothers. By contrast, dependency was negatively associated with symptoms of PPD, suggesting that this personality dimension might protect against PPD. Moreover, clinically depressed mothers had higher levels of self-criticism than non-depressed mothers

(Priel and Besser, 1999; Besser and Priel, 2003). Another study (Vliegen and Luyten, 2009) found that depressed mothers tended to show increased levels of dependency, but this trend failed to reach significance.

Boyce and Parker (1989) developed the Interpersonal Sensitivity Measure (IPSM) as a self-report measure of the construct of interpersonal sensitivity, which they defined as "undue and excessive awareness of and sensitivity to, the behavior and feelings of others". This construct has also been described as a general sensitivity to social feedback, vigilance with regard to others' reactions, increased concern about the behavior and statements of others, and fear of perceived or actual criticism by others (Boyce et al., 1993). One prospective study included in the review (Boyce et al., 1991) found significantly increased risks for PPD in women with high interpersonal sensitivity, demonstrating the ability of the IPSM to predict the development of initial depressive episodes, the recurrence of depression six months following childbirth, and non-remission of depressive symptoms among depressed inpatients.

Much more common in studies about PPD is the vulnerable personality style. Boyce et al. (2001) developed the Vulnerable Personality Style Questionnaire (VPSQ), used in numerous prospective studies of PPD to measure a composite trait including dimensions generally considered to be associated with vulnerability, such as anxiety, worry, sensitivity, unassertiveness, volatility, and to a lesser extent obsessionality. Several studies (Johnstone et al., 2001; Fisher et al., 2002; Dennis et al., 2004; Boyce and Hichey, 2005; Gelabert et al., 2011) concluded that vulnerability was a risk factor for PPD; Boyce and Hichey (2005) reported that high VPSQ scores were associated with an increased risk of major depression in the six months after birth even after controlling for other variables.

Various studies (Vliegen et al., 2006; Grant et al., 2008; Gourounti, 2015; Axfors et al., 2017) concluded that the trait anxiety was a risk factor for PPD, and this trait contributes significantly to explaining the severity of PPD in all the studies in this review. Measures of adult attachment and trait anxiety during late pregnancy might help identify women at high risk of developing PPD (Axfors et al., 2017). Baseline trait anxiety might also predict postnatal anxiety and mood disorders: Grant et al. (2008) found that women with elevated levels of self-reported anxiety were significantly more likely to meet diagnostic criteria for an anxiety or mood disorder during the seven months following birth.

Another trait that was examined in various studies is perfectionism. Perfectionism is a risk factor for many psychopathological disorders (Limburg, 2017), and different studies have found associations between perfectionism and depression (Enns et al., 2005; Huprich, 2008). Although one of the studies included in this review (Maia et al., 2012) concluded that perfectionism was not a risk factor for PPD, other confirmed that this trait is a risk factor for PPD (Gelabert et al., 2012). Using one-dimensional assessment measures, Egan et al. (2011) demonstrated that perfectionism was a predictor of postpartum depressive symptoms. Using Hewitt and Flett's construct of multidimensional perfectionism (HMPS, 1991), Hewitt and Flett (1991) found that self-oriented perfectionism and socially-prescribed perfectionism were associated with depressive symptoms during pregnancy, but only the socially prescribed perfectionism dimension predicted depressive postpartum symptoms. This result highlight the importance of interpersonal dimension and extrinsic motivation in maladaptative perfectionism.

Four of the studies in this review (Maliszewska et al., 2017a; Marín-Morales et al., 2014; Imsiragic et al., 2014 and Van Bussel et al., 2009) evaluated McCrae and Costa's (1999) "Big Five" personality traits (openness to experience, conscientiousness, agreeableness, extraversion, and emotional stability) as risk factors for PPD. All concluded that agreeableness and conscientiousness were not risk factors for PPD, but their findings on openness to experience differed. Whereas Maliszewska et al. (2017a) found that this trait was not related PPD, Van Bussel et al. (2009) concluded that it increased the risk of depression 25 weeks after delivery and Imsiragic et al. (2014) found that it decreased the risk of developing depression 6–9 weeks after delivery.

Nine studies in this review (Maliszewska et al., 2016a, 2016b; Verkerk et al., 2005; Boyce et al., 1991) evaluated the relationship between extroversion/introversion and PPD. Extroversion is related to positive emotions such as happiness, optimism, and enthusiasm as well as to security, activation, and interest for social interaction (Watson and Clark, 1997; Yang and Ha, 2019). This trait is associated with reduced vulnerability to affective disorders (Kotov, 2010), increased social support (Rhonda et al., 2012), and successful adjustment to childbirth stressors (Johnston et al., 2013). Introversion could be associated with the onset of emotional disorders and poor adjustment during the perinatal period (Peñacoba-Puente, 2016). Four studies in this review (Maliszewska et al., 2016a, 2016b; Verkerk et al., 2005; Boyce et al., 1991) found that women with low extroversion/high introversion had a higher risk of PPD. By contrast, five studies in this review (Maliszewska et al., 2017a; Marín-Morales et al., 2014; Meltzer-Brody et al., 2013; Imsiragic et al., 2014; Van Bussel et al.,2009) found no relationship between this personality dimension and PPD, corroborating the findings of prospective studies that found that extroversion/introversion does not predict vulnerability to depression (Hirschfeld, 1989).

By far the trait explored in the greatest number of studies included in this review was neuroticism. Originally defined by Eysenck (1967), neuroticism is often considered as an endophenotype of the genetic predisposition for affective disorders (Lahey, 2009), as genetic factors that influence individual variation in neuroticism overlap substantially with those that influence the manifestations of other internalizing disorders (Hettema, 2006). In this review, 17 studies support the conclusion that neuroticism is associated with PPD (Axfors et al., 2017; Boyce et al., 1991; Chang et al., 2014; Gelabert et al., 2012; Hipwell et al., 2004; Iliadis et al., 2015; Imsiragic et al., 2014; Maliszewska et al., 2017a, 2017b; Maliszewska et al., 2016b; Marín-Morales et al., 2014; Meltzer-Brody et al., 2013; Saisto et al., 2001; Tian et al., 2012; Van Bussel et al., 2009. Verkerk et al., 2005; Martín-Santos et al., 2012). Neurotic individuals tend to experience intense negative emotions in response to stressful situations, and pregnancy and childbirth can be stressful. Neurotic individuals often perceive themselves as ineffective at coping and engage in worrying, rumination, or emotional avoidance. Interest in neuroticism has increased in recent years (Barlow, 2014), and various authors have concluded that neuroticism is among the most important predictive factors for depression both in pregnancy and in the postpartum (Dennis and Boyce, 2004; Podolska et al., 2010). Additionally, neuroticism has been associated with low perceived social support (Swickert et al., 2010) and poor adjustment to childbirth stressors (Johnston et al., 2013).

Nevertheless, not all studies fully support the hypothesis that neuroticism might predict PPD. Two studies in this review (Imsiragic et al., 2014; Maliszewska et al., 2016a) concluded that neuroticism is not a risk factor for PPD. However, Maliszewska et al. (2016a) studied depressive symptoms in the first week after childbirth, possibly confounding concepts of postpartum blues and PPD. In stark contrast to these findings, Imsiragic et al.'s (2014) found that neuroticism predicted EPDS score at 3–5 days postpartum (corresponding to the postpartum blues that was not associated with neuroticism in Maliszewska et al. (2016a)), but did not predict scores at 6–9 weeks postpartum.

In recent years, the growing interest in PPD has led to initiatives that aim to go beyond merely identifying PPD after it develops to identifying women at risk of developing depression during pregnancy or after giving birth (Gelabert et al., 2021). To this end, the International Marcé Society for Perinatal Mental Health's 2013 position statement on the psychological evaluation and detection of depression during the perinatal period (Austin, 2014) recommends assessing personality traits, among other risk factors.

4.4. Meta-analysis

We performed a meta-analysis of the association between neuroticism and PPD. We found wide heterogeneity among the 13 studies included in the meta-analysis. Our findings from the meta-analysis seem to confirm those of our qualitative analysis included in the review.

4.5. Strengths and limitations

To our knowledge, this is the first systematic review to analyze personality traits as possible risk factors for PPD and the first meta-analysis to measure the effect of neuroticism as risk factor for PPD. Search terms were carefully selected to capture all possible studies in the five indexed databases. The participation of two reviewers helped ensure the validity of our results.

However, several limitations should be considered. Not uncommon for evidence syntheses, the body of studies included here likely suffers from publication bias.

To guard against this bias, we tried to ensure that our literature search was as comprehensive as possible. Nevertheless, only studies published in English were eligible for inclusion, although the articles included reported studies done in a wide range of countries, including those where other languages are dominant. Moreover, we used funnel plots and the Egger test and found that small studies were more likely to report larger effects, which may be related to publication bias.

There is also potential reporting bias at the study level. Most (71%) of the included studies report only significant associations, and we cannot know whether the authors disregarded negative results. Furthermore, the design of the studies included in the review precludes the possibility of discussing a causal relationship between personality and PPD.

Our analyses were limited by differences in the methods used in different studies. Whereas some studies used clinical interviews to diagnose depression, most used only screening tools relying on self-reporting to detect depressive symptoms; furthermore, different studies also used different cutoff scores of the screening tools to diagnose PPD, thus making it difficult to compare their results.

Self-reported personality tests can be complicated by subjects' moods, limited insight, and response styles; additionally, it can be difficult for these tests to distinguish traits from the effects of stable environmental contexts (Chmielewski and Watson, 2009). Additionally, temperament and personality are not a fixed, static set of characteristics, but rather are dynamic constructs that develop over the lifespan and change in response to maturation and life circumstances. For example, life stressors and major shifts in social roles and relationships can contribute to personality change (Fraley and Roberts 2005, Kandler et al. 2010). The differences in the timepoints when personality traits and PPD were assessed also make it difficult to compare the results of the different studies. Additionally, because the studies that used multivariate analyses adjusted for different variables, their results might not be comparable.

We introduced an analysis as a mean to investigate statistical heterogeneity in a meta-analysis: meta-regression analysis. Meta-regression has low power to detect statistically significant associations when there is a small number of studies, so it should be viewed as exploratory.

Finally, although a wide variety of traits were explored in the studies included, most studies focused on only one or two traits.

Our meta-analysis focused only on neuroticism, but it would be interesting to conduct meta-analyses on other traits when data become available.

5. Conclusion

The relationship between personality traits and PPD is complex. Our findings support the hypothesis that certain personality traits are associated with increased vulnerability to PPD; among these, the evidence is strongest for neuroticism. The evidence suggests that vulnerable personality style and trait anxiety are also associated with PPD. Further studies with designs that can achieve more robust results (e.g., prospective longitudinal studies of women without a prior history of mood disorders diagnosed by clinical interviews as well as screening tools) should aim to determine the best timepoint to assess personality traits (especially neuroticism, vulnerable personality style, and trait anxiety) and PPD as well as to understand the mechanisms through which these traits increase the likelihood of PPD. To mitigate potential selective analysis reporting, authors are encouraged to prospectively register their study protocol and statistical analysis plan before collecting the data.

To ensure early detection and optimal treatment, we need to understand PPD better.

Contributors

Author MP: conceptualized the study and took primary responsibility for preparing the manuscrit and carry out all the aspects of the systematic review. Author EG: assisted with the design of the study, reviewing potential studies to include, assessing the quality of studies included, and manuscript preparation. Author SS: provided conceptual input for the study design and contributed to the preparation of the manuscript. Authors AT, AR and LG: Supervision and review.

Role of the funding source

This work was supported partially by Fundació TecnoCampus

Author declaration statement

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication.

Declaration of Competing Interest

We declare no conflicts of interest.

Acknowledgments

We acknowledge the support of the Secretaria d'Universitats i Recerca del Departament d'Economia i Coneixement, Generalitat de Catalunya (SGR2014/1114; SGR2017/1798).

Appendix A

Results of mixed effects bivariate meta-regression models of characteristics of studies.

Characteristics of studies	e^{β} (95% confidence interval)*	se	p	R^2
Design				
Cohort (Reference)	-	0.84	0.211	7.61%
Case-control	1.84 (0.67, 5.04)			
Country				
Nordic countries (Europe) (Reference)	-	0.94	0.084	37.64%
Europe except Nordic countries	2.23 (0.88, 5.66)			
Timepoint(s) of personality assessment				
Pregnancy (Reference)	-	0.06	<0.001	100%
Postpartum	0.25 (0.15, 0.41)			
EPDS cutoff				
<12 (Reference)	-	0.78	0.686	4.24%
≥ 12	1.29 (0.32, 5.18)			
Diagnostic approach				
Diagnoses (Reference)	-	0.74	0.417	3.8%
Symptomatology	1.51 (0.51, 4.47)			
Timepoint(s) of depression assessment				
1 week after birth (Reference)	-	0.74	0.701	27.22%
6–8 weeks after birth	1.26 (0.34, 4.65)	0.93	0.573	
24 weeks of 1 year after birth	1.45 (0.35, 6.03)			
Type of variable to assess neuroticism				
Categorical variable (Reference)	-	0.09	0.002	84.69%
Continuous variable	0.35 (0.19, 0.63)			

e^{β}: exp (β coefficient); se: standard error; p: probability; R^2: proportion of variance explained.

* eβ below 1= smaller effect size; eβ above 1= higher effect size.

EPDS: Edinburgh Postnatal Depression Scale

Cohort studies ($n = 6$); Case control studies ($n = 2$); Nordic countries ($n = 4$); Europe except Nordic countries ($n = 7$); Pregnancy personality assessment ($n = 4$); Postpartum personality assessment ($n = 9$); Diagnoses PPD approach ($n = 3$); Symptomatology PPD approach ($n = 10$); 1 week after birth depression assessment ($n = 3$); 6–8 weeks after birth depression assessment ($n = 4$); 24 weeks after birth depression assessment ($n = 5$); Categorical variable ($n = 5$); Continuous variable ($n = 8$).

Appendix B

Results of mixed effects multiple meta-regression model of characteristics of studies.

Characteristics of studies	e^{β} (95% confidence interval)*	se	p	R^2
Country				
Nordic countries (Europe) (Reference)	-	0.36	0.285	
Europe except Nordic countries	1.36 (0.74, 2.49)			
Timepoint(s) of personality assessment				
Pregnancy (Reference)	-	0.15	0.036	100%
Postpartum	0.39 (0.16, 0.92)			
Type of variable to assess neuroticism				
Categorical variable (Reference)	-	0.32	0.573	
Continuous variable	0.79 (0.32, 1.97)			

e^{β}: exp (β coefficient); se: standard error; p: probability; R^2: proportion of variance explained.

* eβ below 1= smaller effect size; eβ above 1= higher effect size.

EPDS: Edinburgh Postnatal Depression Scale.

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