Risk factors for paternal perinatal depression and anxiety: A systematic review and meta-analysis

Abstract

Aim: To identify the risk factors associated with paternal perinatal depression and anxiety.

Methods: Studies published between January 1950 to December 2017 which report paternal depression and anxiety in the perinatal period were obtained from five different databases. In total 84 studies were included in the systematic review, and 31,310 participants from 45 studies were included in the final meta-analysis.

Results: Risk factors obtained were classified based on the frequency of distribution of factors. Maternal depression is an important risk factor for fathers in the postnatal period (OR= 3.34, 95% CI (2.51-4.46)). Marital distress was also linked to a two-fold increase in the likelihood of paternal depression in the postnatal period (OR=2.16, 95% CI (1.47-3.19)). Parenting stress as a risk factor was strongly and significantly associated with paternal anxiety in perinatal period (OR= 14.38, 95% CI (7.39-27.97)).

Conclusion: The findings suggest that maternal depression, marital distress, and parental stress are important risk factors for fathers' mental health in the perinatal period. The current meta-analysis also identifies gender role stress, domestic violence, and mismatched expectancies from pregnancy and childbirth as the risk factors which are unique to fathers only in the perinatal period. Future intervention programs should screen and target fathers with no previous children, a depressed partner, and aim to enhance relationship satisfaction.

Keywords: depression, anxiety, fathers, pregnancy, childbirth, perinatal

Public Significance Statement: Like women, men also show signs and symptoms of depression and anxiety in the perinatal period. Meta-analysis revealed that partner's depression, marital distress, and parenting stress are significant risk factors to fathers' mental health in perinatal period. Counteracting these risk factors may reduce the risk of depression and anxiety in fathers in the perinatal period.

Author Note: Some of the data and ideas in the manuscript were presented at Australian Psychological Association and Asian Association of Social Psychology conferences in 2019.

Abbreviations

APA:	American Psychiatric Association
BDI:	Becks Depression Inventory
CES-D:	Centre for Epidemiological Studies Depression Scale
CI:	Confidence Interval
CIDI-SF:	Composite International Diagnostic Interview-Short Form
COPE:	Centre for Perinatal Excellence
DASS:	Depression Anxiety Stress Scales
DIS:	Diagnostic Interview Schedule
DSM-5:	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
EPDS:	Edinburgh Postnatal Depression Scale
GHQ:	General Health Questionnaire
GMDS:	Gotland Male Depression Scale
HADS:	Hospital Anxiety and Depression Scale
IPV:	Intimate Partner Violence
MeSh:	Medical Subject Headings
MMAT:	Mixed Method Appraisal Tool
NICU:	Neonatal Intensive Care Unit
NIMH:	National Institute of Mental Health
OR:	Odds Ratio
PRISMA:	Preferred Reporting Items for Systematic Review and Meta-Analysis
SADS:	Schedule for Affective Disorder Scale
SCID:	Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders
STAI-S:	State-Trait Anxiety Inventory-State Anxiety Scale
STAI-T:	State-Trait Anxiety Inventory-Trait Anxiety Scale
WFC:	Work Family Conflict
WHO:	World Health Organisation

Depression is a common but serious mental health concern (World Health Organisation [WHO], 2017). Depression is a type of mood disorder characterised by anhedonia, loss of appetite, sleep disturbance, low energy, and typical cognitions such as hopelessness (American Psychiatric Association [APA], 2018). According to the WHO (2017) 322 million people suffered from depression in 2015. Between 2005 and 2015, the total estimated prevalence of depression had increased by 18.4%. In most cases, depression co-occurs with anxiety. Anxiety is defined as a feeling of excessive fear and worry, with anticipation of future threat and is characterised by somatic symptoms such as palpitations, sweating, and trembling (APA, 2018). The global prevalence of anxiety in 2015 was about 264 million or 3.6% of the world population (WHO, 2017).

The symptoms of depression and anxiety can be elevated by stressful situations such as trauma and major life events (e.g. pregnancy and childbirth). Several studies have established a relationship between pregnancy and childbirth and elevated depressive and anxiety symptoms (Gavin et al., 2005; Gaynes et al., 2005; Goodman, 2004). Depression or anxiety experienced during pregnancy (1st trimester until 3rd trimester) is known as prenatal depression or anxiety. Postnatal anxiety or depression occurs after childbirth and up to one year after the birth of the infant. Thus, depression or anxiety that occurs from the 1st trimester of pregnancy up to 12 months after childbirth is collectively termed perinatal depression or anxiety (APA, 2018).

The impact of depression and anxiety on mental health during the perinatal period has been studied extensively among mothers, but has received much less attention in relation to fathers (Dudley, Roy, Kelk, & Bernard, 2001). Although fathers' mental health has only received more focus over the past decade, studies have found that a significant portion of

fathers also suffer from depression and anxiety in the perinatal period (Centre of Perinatal Excellence [COPE], 2017; Wee et al., 2013).

Giallo and colleagues (2012) reported a postnatal depression prevalence of 10% in 3,219 Australian fathers. Gawlik et al. (2014) reported similar results in their study of new fathers in a community sample of 320 German fathers, among whom 9.8% experienced prenatal depression and 7.8% of fathers were depressed postnatally. These results were replicated in a meta-analysis that estimated the prevalence of paternal perinatal depression at 8.4% (Cameron, Sedov, & Tomfohr-Madsen, 2016). Research has shown that the prevalence rates of non-Western perinatal depressed fathers are similar to those in Western countries. Mao, Zhu, and Su (2011) reported that 12.5% of Chinese fathers in their sample reported perinatal depression. Similarly, Nishamura and Ohashi (2010) reported 11.6% of Japanese fathers suffered from perinatal depression. This rate closely aligns with the 10% prevalence of depressed fathers in the perinatal period in samples from USA and Australia (Giallo et al., 2012; Paulson & Bazemore, 2010).

Although the rates of perinatal depression are significant, it is likely that these rates underrepresent the true prevalence in fathers given there may be a gendered context in men underreporting depressive symptoms, leading to underdiagnoses (O'Brien et al., 2017). While both men and women express depression as low mood with reduced activity, depression in men may be 'masked' with externalised behaviour and disorders such as substance abuse, avoidance behaviour, and anger (Addis, 2008; Cochran & Rabinowitz, 2000). This masked phenomenon is termed as 'masked depression' or 'masculine depression' (Addis, 2008). It has been hypothesised that due to gender norms some depressive men may display the aforementioned behaviours and disorders instead of overt, typical depressive symptoms because these men may feel uncomfortable or even fearful about displaying a depressive affect. Moreover, many men have negative attitudes towards help-seeking, and therefore are

less likely to seek professional help as a result of the negative attitudes (Addis, 2008; Good, Dell & Mintz, 1989) influenced by masculine gender norms (Addis, 2008). Possible masculine gender norms include the traditional societally-held view of the man as the main provider or the breadwinner for the family, along with societal expectations of emotional inexpressiveness, toughness, competitiveness, and of holding power over women (Addis & Cohane, 2005). These masculine gender norms discourage help-seeking when men experience depression and/or anxiety.

Similar to the frequencies for perinatal depression, studies have also estimated the prevalence for anxiety in the perinatal period. Quinlivan and Condon (2005) and Tohotoa and colleagues (2012) estimated a prevalence of 12% of 50 fathers experiencing prenatal anxiety and 2.4% of 244 fathers experiencing postnatal anxiety, respectively, in Australia. Figueiredo and Conde (2011) reported a prevalence of 10% for prenatal anxiety among 260 Portuguese fathers. These results closely align with the estimated 3% prevalence of paternal postnatal anxiety in 89 New Zealand fathers by Carter, Mulder, Bartram, and Darlow (2005). In their recent systematic review, Leach, Pyser, Cooklin, and Giallo (2016) estimated the prevalence of paternal perinatal anxiety between 2-18%. Similar to the studies in Western countries, Koh et al. (2015) estimated a prevalence of 3.4% for postnatal anxiety in 622 Chinese fathers and 2.6% for prenatal anxiety.

The significant prevalence of paternal perinatal depression and anxiety in both Western and non-Western countries suggests that the mental health of fathers is a significant public health concern. The affected population is most likely to incur the increased cost of healthcare services associated with increased contact with general practitioners, psychologists, and psychiatrists (Edoka, Petrou, & Ramchandani, 2011). Additionally, paternal perinatal anxiety and depression can have a negative impact on an infant and child's behaviour, mental health, and learning capabilities. For example, Ramchandani, Stein, Evans

and O'Connor (2005) reported in their study that a depressed father had a 109% higher risk for having children with psychiatric disturbances. Moreover, depressed fathers are less likely to be engaging with their toddlers which may affect a child's cognitive development (McLearn et al., 2006). Furthermore, hidden or masked depression, resulting in externalising symptoms such as physical illness, alcohol and drug abuse, and domestic violence, may delay treatments of depression. Research has reported that hidden depression appears to be a contributing factor of suicide in men (Marcus et al., 2012).

Prevention has been identified as the key to reducing the healthcare costs in relation to paternal depression and anxiety, and the negative impacts on children (COPE, 2017). To facilitate the design of prevention programs for paternal perinatal depression and anxiety, identifying risk factors is imperative (Edoka et al., 2011).

A risk factor is defined as any characteristic or attribute the increases the likelihood of developing a disease or injury (WHO, 2017). A large body of literature has reviewed the risk factors associated with maternal depression and anxiety in the perinatal period. In their systematic review, Lancaster et al. (2010) reported history of depression, lack of social support, lower income, lower education, smoking, single status, and poor relationship quality as risk factors for maternal prenatal depression. In the postnatal period, a history of depression, unintended pregnancy, lower education, single status, lower income, and lower education were found to be risk factors associated with maternal postnatal depression (Azad et al., 2019; Fiala, Švancara, Klánová, & Kaśpárek, 2017). However, similar to the research into prevalence of perinatal mental health disorders, research into risk factors associated with paternal perinatal mental health has received less attention compared to mothers.

Several studies into risk factors associated with perinatal depression and anxiety in fathers have identified factors which are similar to risk factors identified in mothers during

the perinatal period. Maternal depression has been found to be significantly correlated to paternal perinatal mental health; with published correlations ranging between 0.2-0.76 (Bielawska-Batorowicz & Kossakowska-Petrycka, 2006; Matthey et al., 2000). Fathers are 2.5 times more likely to be depressed six weeks postnatally if their partner is also suffering from postnatal depression (Matthey et al., 2000). Low socioeconomic status has also been reported to be associated with paternal perinatal mental health disorders. Fathers with lower education status may have reduced chances of gaining well-paying employment (Gao et al., 2009) and the arrival of a new baby may financially strain fathers who are not employed full-time (Bergström, 2013). Marital distress is another risk factor reported in the literature. Distress in the marital relationship is likely to add to the stress related to the arrival of a new baby and may cause significant distress in fathers during the perinatal period (Bergström, 2013; Nishimura et al., 2015). Fathers with a history of previous psychiatric illness are reported to be more likely to suffer depression or anxiety during the perinatal period (Nishimura & Ohashi, 2010; Pinheiro et al., 2011; Ramchandani et al., 2008; Suto et al., 2016). Furthermore, the lack of social support is also likely to affect the mental health of fathers in the perinatal period. Boyce and colleagues (2007) suggest that in their sample of Australian fathers, fathers were at a higher risk for emotional distress if they were dissatisfied with the social support from their partner, family, and friends.

Apart from those risk factors, unplanned pregnancy (Gao et al., 2009; Nishimura & Ohashi, 2010), lack of parenting skills (Bradley, Slade & Leviston 2008; Zhang et al., 2016), and substance abuse (Bronte-Tinkew et al., 2007) are also identified as risk factors for paternal perinatal depression and anxiety. The relationship between age and new fathers' depression and anxiety is inconclusive. Contradictory results have been found with some studies suggesting that younger age (<30 years) is a risk factor for paternal perinatal mental health disorder (Bielawska-Batorowicz, & Kossakowska-Petrycka, 2006; Bergström, 2013)

while other studies suggest that older age is more likely to be a risk factor for fathers in the perinatal period (Bronte-Tinkew et al., 2007; Ramchandani et al., 2008; and Stramrood et al., 2013).

The above risk factors for paternal perinatal depression and anxiety have been reported in individual studies. To the authors' knowledge, there is no published systematic review in this field that includes clearly defined inclusion and exclusion review criteria, and assessments of methodologic qualities of the reviewed studies with explicit criteria of the methodological quality (Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 2000). In this article, a strict systematic approach has been employed to identify and summarise the risk factors for paternal perinatal depression and anxiety in the literature, followed by a meta-analysis to estimate the effects of the risk factors on paternal perinatal depression or anxiety. These methods are comparable with those in the literature with regards to prevalence of paternal perinatal mental illness (Cameron et al., 2016). The current study aims to answer the following research questions: (i) what are the risk factors associated with paternal perinatal depression and anxiety; and (ii) what are the unique risk factors for fathers' perinatal depression and anxiety compared to those for mothers.

Method

A systematic review and meta-analysis on paternal perinatal depression and anxiety was conducted to identify risk factors in peer-reviewed articles. Methodological considerations included the time of assessment of depression and anxiety, and the measures used to assess depression and anxiety. Risk factors were ranked based on the frequency of the distribution of factors identified through review. Preferred Reporting Items for Systematic

Review and Meta-Analysis (PRISMA; Figure 1) guidelines were followed (Hutton et al., 2015; Moher et al., 2015).

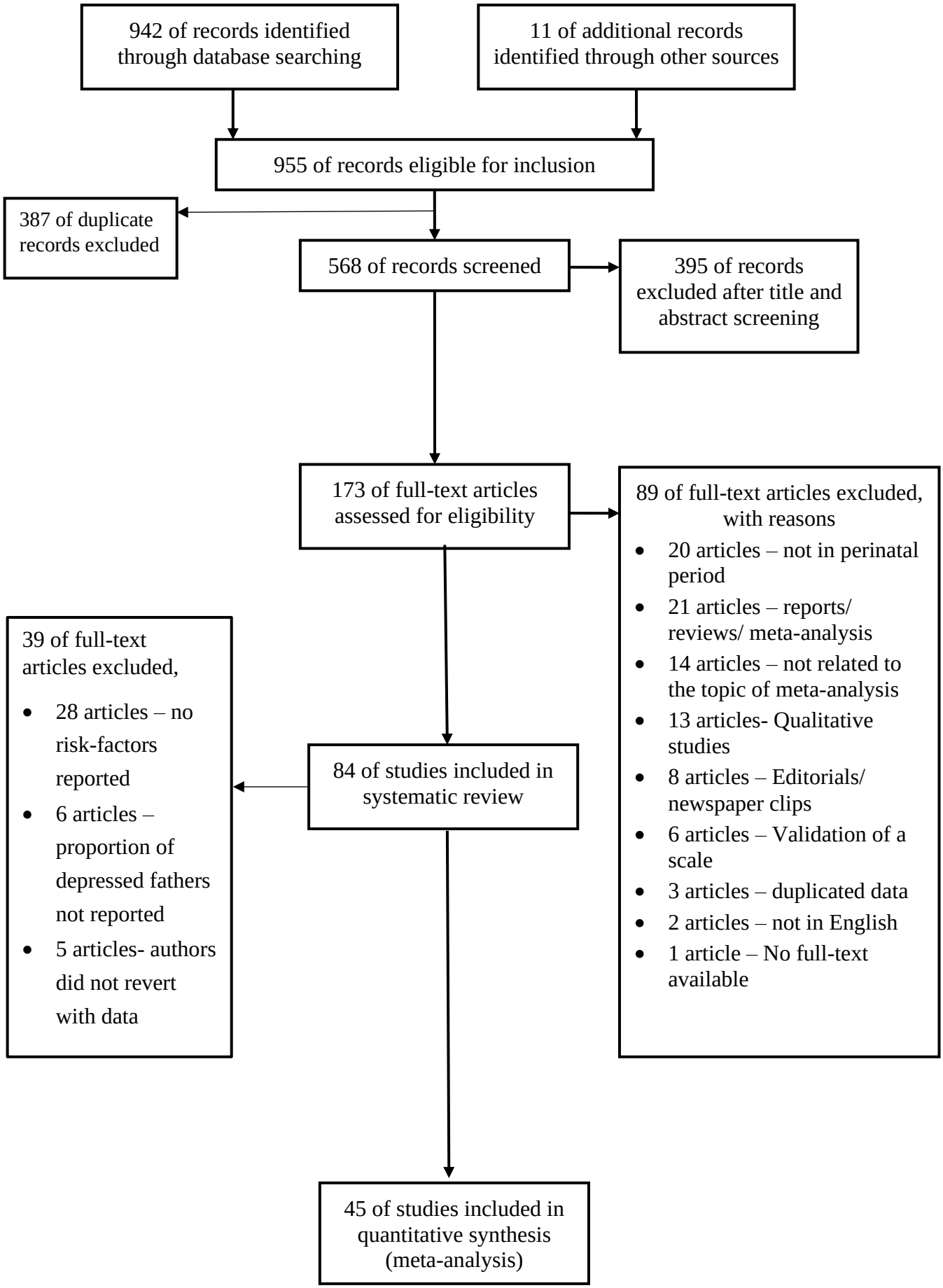

Figure 1. PRISMA flow of result of systematic review and meta-analysis

Search Strategy

Five electronic databases – CINAHL, Medline, PubMed, PsychInfo, and Scopus were searched for articles from January 1950 to December 2017 using Medical Subject Headings (MeSH) terms of fathers, dad, fatherhood, men, male, paternal, prenatal, antenatal, pregnancy, postnatal, postpartum, childbirth, perinatal, depression, anxiety, mental health disorder. The first author performed searches of all databases using these keywords and their several combinations (e.g., *fathers or dad or fatherhood and postnatal and depression and anxiety*). The search was limited to papers published in English, in peer-reviewed journals, comprised of MeSH terms within the title or abstract of the article, and contained male participants over the age of 18 years.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were applied multiple times throughout the entire process. Exclusion criteria included studies not being in English, studies which did not have keywords in either their title or abstract, studies which did not include male participants, participants below the age of 18 years, and studies with a focus on unhealthy infants. When full-texts were being reviewed, articles were excluded if studies were not in the perinatal period; and reviews, editorials, systematic reviews, meta-analyses, comments, replies, animal studies, and qualitative studies were also excluded. Studies were also excluded if they used data from shared databases in order to avoid duplication of data. Studies that reported validation of various depression scales were also excluded. Lastly, inclusion-exclusion criteria were applied when the studies were being catalogued according to the risk factors. The exclusion criteria included studies that did not report any risk factors associated with paternal perinatal depression and anxiety. Studies that did not report an estimated prevalence of perinatal depression and/or anxiety in their sample were also excluded. Studies were

excluded if they reported prevalence of depression and/or anxiety in their sample in mean and standard deviation, but not enough information was provided to determine the estimated prevalence. Longitudinal studies had multiple time points when data was collected. In order to compare with cross-sectional studies, the largest sample size reported in longitudinal studies was included in the review. If the longitudinal studies had a consistent sample size throughout the study, then the first reported sample size was included.

Study Selection

All three authors independently assessed the eligibility of the retrieved studies. Disagreement about the inclusion of a study was resolved through discussion among the three authors. The titles and abstracts of the articles were coded as either 'yes', 'no' or 'maybe' to determine eligibility. The studies marked as 'no' were removed and studies marked as 'yes' or 'maybe' were included to be reviewed thoroughly for inclusion. If the articles did not meet the inclusion and exclusion criteria, then they were removed from the review.

Quality Assessment

Eligible studies were assessed for methodological quality using the Mixed Methods Appraisal Tool (MMAT), which facilitates appraisal of studies using common methods and methodologies with few generic quality criteria (Pace et al., 2012). The checklist has five specific sets of criteria and has been shown to be a valid and reliable tool for methodological quality assessment (Pace et al., 2012). A study was scored out of 100 and higher scores represent higher overall methodological quality. The first two authors independently scored the studies. The third author resolved any discrepancies noted. The MMAT checklist is provided at the end of the paper (Appendix A).

Data Extraction

The first author independently coded the author and year of the study, country of the study, sample size, time points of assessment of depression and anxiety, methods used to assess depression and anxiety, prevalence rate of depression and anxiety in fathers, and the associated risk factors. The second and third authors independently reviewed the table for accuracy and completeness. If a study used multiple methods to measure the symptoms of depression and anxiety at the same time, the symptoms reported by clinical interviews was given priority over self-report measures such as Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden & Sgavosky, (1987)).

Statistical Analysis

ProMeta, version, 3.0.0. (Internovi, 2015) was used to perform all major statistical analysis given the program's ability to input data in various formats and create summary forest plots, z-value and p-value. Outcomes were reported as Odds Ratios (OR). OR was selected as the reported measure of strength between variables given ORs were the most commonly reported statistic in the included studies and is easily interpretable as well as ProMeta having the functionality to convert other outcomes to ORs. If the included article reported insufficient data to calculate an OR, then the relevant authors were contacted to provide the data. Separate meta-analyses were conducted for each risk factor for depression and anxiety respectively and data pertaining to prenatal and postnatal timeframes. A random effects model was used for all analyses as considerable heterogeneity (inconsistency due to variation in study results rather than inconsistency compatible with chance) was expected. Heterogeneity was assessed using I^2 statistics (Higgins & Thompson, 2002).

Results

Characteristics of studies

Database (i.e. CINAHL, Medline, PsychInfo, PubMed, and SCOPUS) and hand-searching resulted in a total of 995 potentially eligible studies between 1950 and 2017. An initial screening of the title and abstract resulted in 173 articles, of which 89 were excluded after full-text assessment of studies. The agreement rate of the inclusion of a study between authors was measured by Cohen's kappa (κ; Marston, 2010). Initial agreement between authors was moderate ($\kappa = 0.62$). Further screening of the remaining 84 articles resulted in the exclusion of 39 articles, leaving a final 45 articles which are included in the meta-analysis (Fig. 1).

Of the 45 studies included in this meta-analysis, the majority were conducted in the United States of America (n=8), followed by Australia (n=6) and United Kingdom (n=5). The remaining studies were conducted in Finland, Norway, Sweden, Japan, China, Turkey, Iran, and Italy. Sample size of the individual studies varied considerably (n= 12 - 10,975). The total number of participants was 31,310 fathers across the 45 studies. 38 studies used self-report measures such as EPDS; and seven studies employed diagnostic interviews. 30 studies were cross-sectional, and 15 studies were longitudinal. Participants were mainly recruited from maternity hospitals/clinics while prenatal classes were also used to recruit participants. Summaries of each study and their main findings are presented in Table 1 & 2.

Table 1. Major Characteristics of studies, prevalence and risk factors for paternal depression in the perinatal period

ID	Author and Year	Country	Time of Assessment	Measure	Sample size	Cases (%)	Risk Factors
1.	Ahlqvist-Björkorth et al., 2016	Finland	20 weeks gestation	EPDS≥10	153	15 (9.8)	Marital distress
2.	Anding et al., 2016	Germany	2 weeks postpartum	EPDS≥10	276	15 (5.4)	Marital distress, maternal depression, & parental stress
3.	Areias et al., 1996	Portugal	24 weeks gestation	SADS	42	2 (4.8)	
			3 months postnatal		12	2 (16.7)	
			12 months postnatal		42	10 (53.7)	Maternal depression, & history of depression in men
4.	Ballard et al., 1994	U.K.	6 weeks postnatal	EPDS≥13	178	16 (9.0)	Maternal depression
			6 months postnatal		148	8 (5.4)	Maternal depression, unemployment
5.	Bergström, 2013	Sweden	3 months postnatal	EPDS≥11	812	83 (10.3)	Maternal depression, low socio-economic condition, marital distress
6.	Bielawska-Batorowicz & Kossakowska-Petrycka, 2006	Poland	3.5 months postnatal	EPDS≥13	80	22 (27.5%)	Maternal depression, marital distress, high discrepancies between prenatal expectations and

							experience related to family and social life
7.	Bronte-Tinkew et al., 2007	USA	12 months postnatal	CIDI-SF	2,137	115 (5.4)	Unemployment, and substance abuse
8.	Buist et al., 2002	USA	26 weeks gestation	EPDS≥10	197	27 (12.0)	Marital distress
			4 months postnatal		143	9 (5.8)	Gender role stress, marital distress
9.	Carlberg et al., 2017	Sweden	3-6 months postnatal	EPDS≥10	3,656	485 (13.3)	Low socio-economic condition
				EPDS≥12	3,656	295 (8.1)	Low socio-economic condition
				GMDS≥13	3.656	315	Low socio-economic condition
10.	Carro et al., 1993	USA	1 month postnatal	BDI >9	70	7 (10.0)	Maternal depression
11.	Cattaneo et al., 2015	Italy	2-5 days postnatal	EPDS ≥10	122	8 (6.65)	Maternal depression
			2 months postnatal		114	3 (2.63)	History of anxiety and/or panic attacks, maternal depression
			6 months postnatal		119	3 (2.59)	History of anxiety and/or panic attacks, maternal depression,

							thoughts of arrival of the baby
12.	Condon et al., 2004	Australia	23 weeks gestation	EPDS>12 GHQ-28>5 MHI<17	312	16 (5.2) 14 (4.6) 57 (8.2)	Marital distress, alcohol abuse
			3 months postnatal	EPDS>12 GHQ-28>5 MHI<17	276	5 (1.9) 4 (1.5) 31 (11.3)	
			6 months postnatal	EPDS>12 GHQ-28>5 MHI<17	241	5 (2.1) 4 (1.7) 27 (11.2)	
			12 months postnatal	EPDS>12 GHQ-28>5 MHI<17	222	5 (2.3) 7 (3.1) 23 (10.4)	
13.	deMontigny et al., 2013	Canada	8-11 months postnatal	EPDS≥10	76	6 (7.9)	Marital distress, high level of parenting distress, lower parenting efficacy
14.	Dudley et al., 2001	Australia	1-6 months postnatal	EPDS≥12 GHQ≥5 BDI≥10	93 93 92	11 (11.8) 43 (46.2) 16 (17.4)	Marital distress
15.	Escribà-Agüir & Artacoz, 2011	Spain	3rd trimester 3 month postnatal 12 month postnatal	EPDS≥11	623 409 409	43 (6.5) 21 (5.1) 24 (5.9)	Marital distress, maternal depression, prenatal depression
16.	Field et al., 2006	USA	20 weeks gestation	CES-D≥16	156	50 (32.1)	Maternal depression

17.	Fisher et al., 2012	Vietnam	3rd trimester-6 week postnatal	SCID	231	12 (5.2)	Domestic violence, unplanned pregnancy
18.	Gao et al., 2009	China	6-8 week postnatal	EPDS≥13	130	14 (10.8)	Perceived stress, maternal depression, unplanned pregnancy, having a female baby, low social support
19.	Gawlik et al., 2013	Germany	Between 2nd and 3rd trimester 6 weeks postnatal	EPDS>9	102	10 (9.8) 8 (7.8)	Prenatal depression, marital distress
20.	Goodman, 2008	USA	2-3 months postnatal	EPDS≥10	128	17 (13.3)	Maternal depression
21.	Greenhalg et al., 2000	UK	6 days postnatal 6 months postnatal	EPDS>12	78 64	5 (6.4) 4 (6.25)	Marital distress
22.	Hall & Long, 2007	Canada	20-40 weeks gestation 8-10 weeks postnatal	CES-D>16	98	11 (11.22) 21 (21.4)	Work-family conflict Role Disparity
23.	Kamalifard et al., 2014	Iran	6-12 weeks postnatal	EPDS≥12	205	24 (11.7)	Perceived stress
24.	Koh et al., 2014	China	12 weeks gestation 36 weeks gestation	EPDS≥13	451 337	15 (3.3) 14 (4.1)	Marital distress, work-family conflict Poor social support and work-family conflict

			6 weeks postnatal		187	10 (5.2)	Prenatal depression, high work-family conflict
25.	Leathers & Kelly, 2000	USA	3rd trimester 4 month postnatal	CES-D>16	124	9 (7.3) 8 (6.5)	Unplanned pregnancy, marital distress
26.	Mao et al., 2011	China	6- weeks postnatal	EPDS≥13	376	47 (12.5)	Perceived Stress, low social support, maternal depression, and preference of male baby
27.	Matthey et al., 2000	Australia	20-24 weeks gestation 6 weeks postnatal 4 months postnatal 12 months postnatal	BDI>9 and GHQ>7	152 141 125 128	8 (5.3) 4 (2.8) 4 (3.2) 6 (4.7)	 Maternal depression, prenatal depression, Prenatal depression Prenatal depression
28.	Matthey et al., 2003	Australia	6 weeks postnatal	DIS	356	8 (2.3)	Maternal depression, prenatal depression
29.	Morse et al., 2000	Australia	24-26 weeks gestation	EPDS≥10	251	30 (12.0)	Low social support, gender roles stress, marital distress

			36 weeks gestation 4 weeks postnatal 4 months postnatal		204 166 151	18 (8.7) 10 (6.0) 9 (5.8)	
30.	Nath et al., 2016	UK	9 months postnatal	Rutter's 9-item≥13	5220	188 (3.6)	Maternal depression, marital distress, paternal unemployment, low socio-economic condition
31.	Ngai & Ngu, 2015	China	Gestation 6 months postnatal	GHQ>4	200 200	14 (7.0) 21 (10.5)	Prenatal family sense of coherence, prenatal depression, maternal depression
32.	Nishimura & Ohashi, 2010	Japan	1 month postnatal	CES-D≥16 EPDS≥8	146 146	11 (7.5) 17 (11.6)	Unemployment, unplanned pregnancy, and history of psychiatric treatment
33.	Nishimura et al., 2015	Japan	4 month postnatal	EPDS≥8	807	110 (13.6)	Maternal depression, marital distress, history of psychiatric illness, economic anxiety
34.	Pinheiro et al., 2006	Brazil	6-12 week postnatal	BDI>10	386	46 (11.9)	Alcohol abuse, maternal depression
35.	Ramchandani et al., 2008	UK	18 weeks gestation 8 weeks postnatal 8 month postnatal	EPDS≥12	10,975	426 (3.9) 399 (3.6) 378 (3.4)	History of depression, prenatal depression, maternal depression

36.	Roubinov et al., 2013	USA	15 weeks postnatal 20 weeks postnatal	EPDS≥10	92 92	8 (9.0) 8 (9.0)	Unemployment, Marital distress Unemployment, Marital distress,
37.	Soliday et al., 1999	USA	3 weeks postnatal	CES-D≥16	51	13 (25.5)	Parenting stress, maternal depression
38.	Suto et al., 2016	Japan	5-7 days postnatal 2 weeks postnatal 1 month postnatal 2 months postnatal 3 months postnatal	EPDS≥8	207 109 191 195 185	18 (8.7) 4 (3.7) 12 (6.3) 17 (8.7) 13 (7.0)	Prenatal depressive symptoms, history of psychiatric illness
39.	Thorpe et al., 1992	Greece and UK	4-6 weeks postnatal	EPDS≥12	267	2 (0.7)	Maternal depression (UK cohort), maternal emotional stability (Greece)
40.	Top et al., 2016	Turkey	3rd trimester 4-6 weeks postnatal	EPDS≥12	92 84	4 (4.3) 6 (7.1)	Unplanned pregnancy, marital distress, work-family conflict Work family conflict, marital distress
41.	Vismara et al., 2016	Italy	3 months postnatal	EPDS>13	181	12 (6.6)	Parenting stress

			6 months postnatal			4 (2.2)	Parenting stress
42.	Wang & Chen, 2006	Taiwan	6 weeks postnatal	BDI≥10	83	26 (31.3)	Low social support
43.	Wee et al., 2015	Australia	18 weeks gestation 26 weeks gestation 34 weeks gestation	DASS-21>9	150	6 (4.0) 6 (4.0) 7 (4.7)	 Prenatal depression at 26 weeks gestation
44.	Zhang et al., 2016	China	3 days postnatal 2 weeks postnatal 6 weeks postnatal	EPDS>9	166 148 144	35 (20.4) 32 (20.4) 20 (13.6)	Parental self-efficacy, maternal depression, unemployment, low socio-economic status

Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; SADS, Schedule for Affective Disorders; BDI, Beck Depression Inventory; CES-D, Centre for Epidemiological Studies Depression Scale; CIDI-SF, Composite International Diagnostic Interview-Short Form; GHQ, General Health Questionnaire; HADS, Hospital Anxiety and Depression Scale; SCID, Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders; GMDS, Gotland Male Depression Scale; DIS, Diagnostic Interview Schedule, DASS, Depression Anxiety Stress Scales

Table 2. Major characteristics of studies, prevalence and risk factors for paternal anxiety in the perinatal period

ID	Author and Year	Country	Time of Assessment	Measure	Sample size	Case (%)	Risk factors
1.	Fisher et al., 2012	Vietnam	3rd trimester to 6 week postnatal	SCID	231	10 (4.3)	Domestic violence, unplanned pregnancy
2.	Koh et al., 2015	China	Early pregnancy	HADS≥7	622	72 (11.6)	Maternal depression, marital distress, social support and work-family conflict
			36 weeks gestation		337	45 (13.4)	
			6 weeks postnatal		187	27 (14.2)	Maternal depression and marital distress
3.	Matthey et al., 2003	Aus	6 week postnatal	DIS	356	26 (14.1)	Maternal depression
4.	Vismara et al., 2016	Italy	3 months postnatal	STAI-S≥40 STAI-T≥40	181	46 (25.4) 47 (26)	Parenting stress
			6 months postnatal	STAI-S≥40 STAI-T≥40		42 (23.2) 26 (19.9)	Parenting stress

Abbreviations: SCID, Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders; HADS, Hospital Anxiety and Depression Scale; DIS, Diagnostic Interview Schedule; STAI-S, State-Trait Anxiety Inventory-State Anxiety Scale; STAI-T, State-Trait Anxiety Inventory-Trait Anxiety Scale

Associations between paternal perinatal depression and risk factors

The socioeconomic factor of low income was positively associated with paternal postnatal depression. In four studies that investigated this relationship, fathers categorised as having a low income were approximately two times more likely to experience postnatal depression (OR= 2.03, 95% CI (1.83-2.25)) (Bergström, 2013; Carlberg et al., 2017; Nath et al., 2016; Zhang et al., 2016 with zero heterogeneity (I^2 = 0%)).

Maternal depression and paternal depression in the postnatal period were found to be positively associated. This association was examined in 22 studies (Anding et al., 2016, Areias et al., 1996; Ballard et al., 1994; Bergström, 2013; Bielawska-Batorowicz & Kossakowska-Petrycka, 2006; Carro et al., 1993; Cattaneo et al., 2015; Escribà-Agüir & Artacoz, 2011; Field et al., 2006; Gao et al., 2009; Goodman, 2004; Mao et al., 2011; Matthey et al., 2000; Matthey et al., 2003; Nath et al., 2016; Ngai & Ngu, 2015; Nishimura et al., 2015; Pinheiro et al., 2006; Ramchandani et al., 2008; Soliday et al., 1999; Thorpe et al., 1992; Zhang et al., 2016). Maternal depression increased the likelihood of paternal postnatal depression more than three-fold (OR = 3.51, 95% CI (2.63-4.68), *Fig. 2*) with substantial heterogeneity of results (I^2=82.74%). Maternal depression was also found to be positively associated with fathers' depression in the prenatal period. This association was examined in two studies (Ballard et al., 1994; Matthey et al., 2000) (OR = 1.86, 95% CI (1.24-2.77)), with zero heterogeneity.

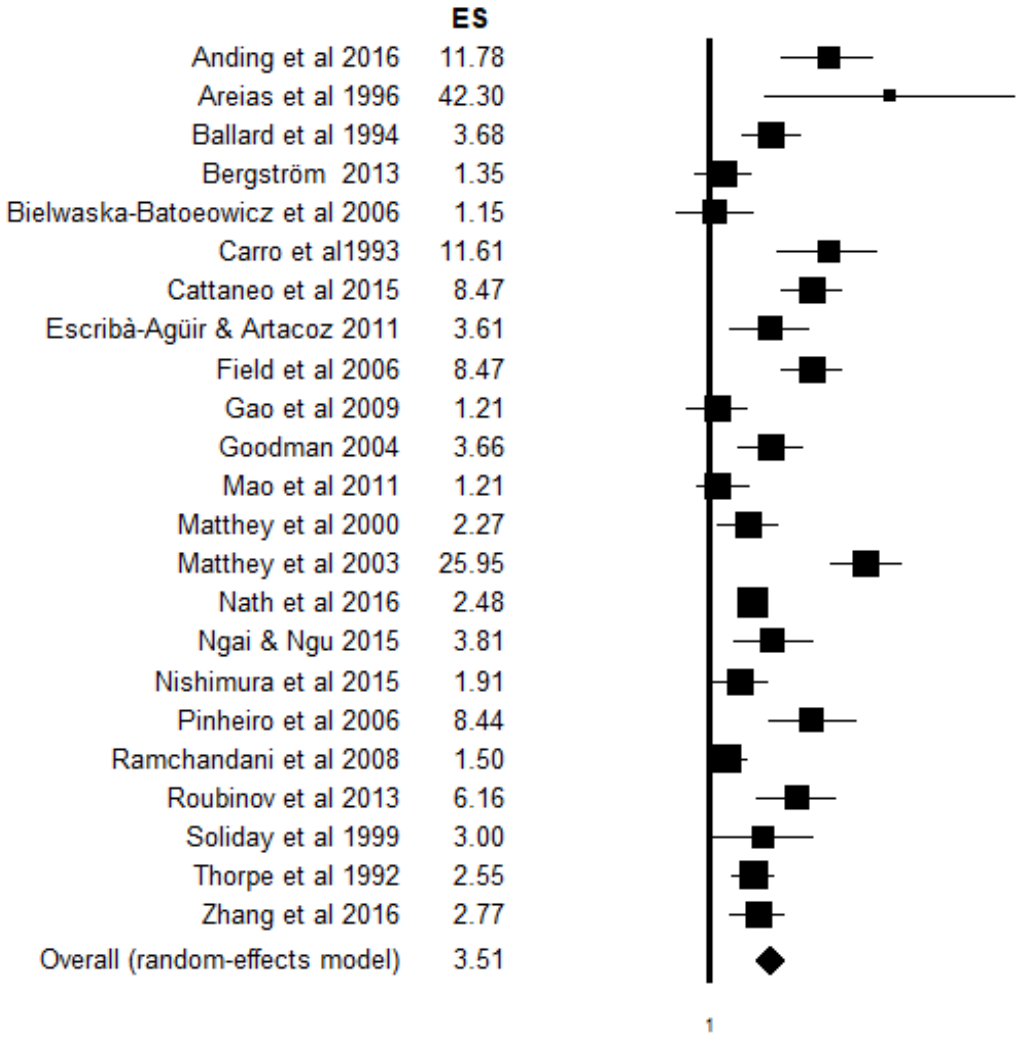

Figure 2 Forest plot of the meta-analysis of risk factor maternal depression for paternal postnatal depression

Positive associations were found between paternal postnatal depression and marital distress and lack of social support. Marital distress was associated with a two-fold increase in the likelihood of paternal depression and this association was examined by 15 studies (OR = 2.16, 95% CI (1.47-3.19), *Fig. 3*) with substantial heterogeneity (I^2=97.78%); (Anding et al., 2016; Bergström, 2013; Bielawska-Batorowicz & Kossakowska-Petrycka, 2006; Buist et al., 2002; Condon et al., 2004; deMontigny et al., 2013; Dudley et al., 2001; Escribà-Agüir & Artacoz, 2011; Gawlik et al., 2013; Greenhalg et al., 2000; Leathers & Kelly, 2000; Nath et al., 2016; Nishimura et al., 2015; Roubinov et al., 2013, Top et al., 2016). Lack of social support increased the likelihood of paternal postnatal depression more than four-fold (OR = 4.76, 95% CI (1.04-21.73)) with substantial heterogeneity (I^2=91.33%); Gao et al., 2009; Mao et al., 2011; Wang & Chen, 2006). Compared to marital distress, lack of social support had a larger effect size. Marital distress and lack of social support were also positively associated with fathers' depression in the prenatal period: marital distress (OR = 3.32, 95% CI (2.19-5.02)), with low heterogeneity (I^2=46.30%); (Ahlqvist –Björkorth et al., 2016; Koh et al., 2014; Leathers & Kelly, 2000; Morse et al., 2000; Top et al., 2016); and lack of social support (OR = 3.71, 95% CI (2.19-6.28) with zero heterogeneity; Koh et al., 2014; Wee et al., 2015).

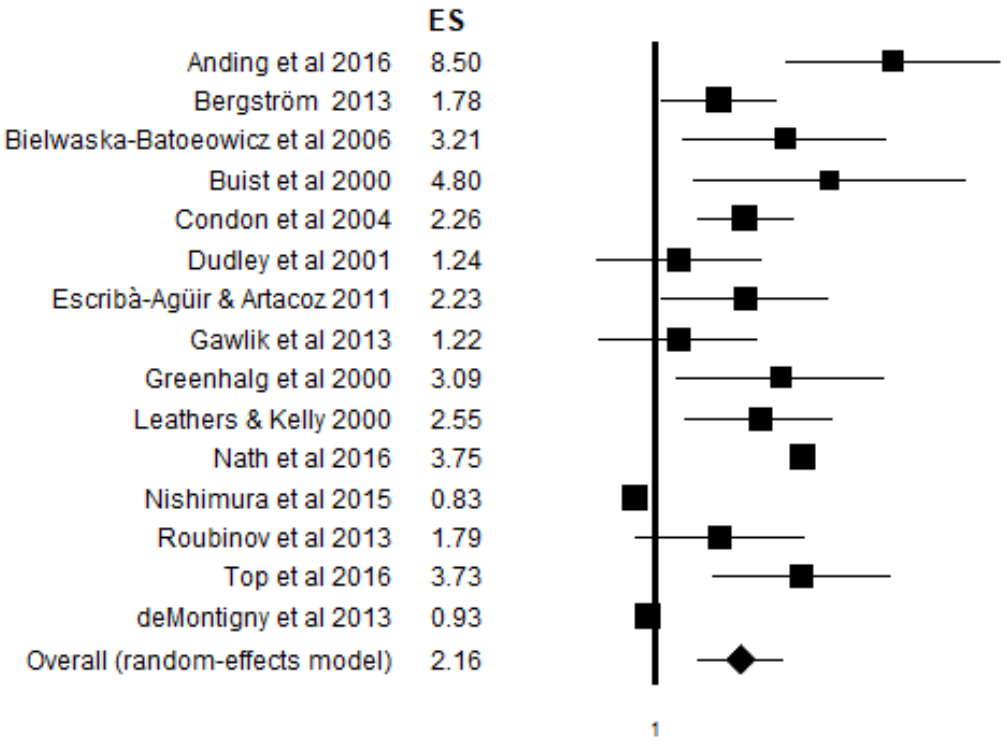

Figure 3 Forest plot of the meta-analysis of risk factor marital distress for paternal postnatal depression

Paternal postnatal depression and prenatal depression, history of psychiatric illness, and alcohol abuse were positively associated. Prenatal depression was associated with a five-fold increase in the likelihood of paternal depression (OR = 5.20, 95% CI (3.13-8.65) with substantial heterogeneity (I^2=75.07%); (Escribà-Agüir & Artacoz, 2011; Gawlik et al., 2013; Hall & Long, 2007; Koh et al., 2014; Matthey et al., 2000; Ngai & Ngu, 2015; Ramchandani et al., 2008; Soliday et al., 1999; Suto et al., 2016). History of psychiatric illness was associated with a more than three-fold increase in the likelihood of paternal depression (OR =3.30, 95% CI (1.95-5.57) with substantial heterogeneity (I^2=87.36%); (Areias, 1996; Bronte-Tinkew et al., 2007; Cattaneo et al., 2015; Nishimura & Ohashi, 2010; Nishimura et al., 2015; Ramchandani et al., 2008; Suto et al., 2016). Alcohol abuse was associated with a more than two-fold increase in the likelihood of paternal depression (OR = 2.40, 95% CI (1.86-3.29) with zero heterogeneity; Bronte-Tinkew et al., 2007; Condon et al., 2004; Pinheiro et al., 2006).

Moreover, paternal postnatal depression and unplanned pregnancy, parenting stress, and preference for a male baby were positively associated with each other in the current meta-analysis. Unplanned pregnancy was associated with a more than three-fold increase in the likelihood of paternal depression (OR = 3.34, 95% CI (2.13-5.23), with low heterogeneity (I^2=30%); (Fisher et al., 2012; Gao et al., 2009; Nishimura & Ohashi, 2010; Top et al., 2016). Parenting stress was associated with a three-fold increase in the likelihood of paternal depression (OR = 3.04, 95% CI (1.07-8.64), with substantial heterogeneity (I^2=92.88%); (Anding et al., 2016; deMontigny et al., 2013; Soliday et al., 1999; Vismara et al., 2016; Zhang et al., 2016). Preference for a male baby was associated with a one and a half times increase in the likelihood of paternal depression (OR = 1.5, 95% CI (1.04-2.38), with zero heterogeneity; (Gao et al., 2009; Mao et al., 2011). Positive association between unplanned pregnancy and paternal prenatal depression was also found in one study (Top et al., 2016).

The risk factor increased the likelihood of paternal prenatal depression by a more than two-fold (OR = 2.68, 95% CI (1.10-6.55)).

Furthermore, work family conflict (WFC) and perceived stress were associated with paternal depression in the postnatal period. WFC was associated with a more than four-fold increase in the likelihood of paternal depression (OR = 4.85, 95% CI (1.51-15.59), Koh et al., 2014). Perceived stress (OR = 7.51, 95% CI (1.14-49.52), with substantial heterogeneity (I^2=95.92%); (Gao et al., 2009; Kamalifard et al., 2014; Mao et al., 2011) was a larger effect. WFC was also positively associated with fathers' depression in the prenatal period with an OR = 3.53, 95% CI (2.01-6.23), with low heterogeneity (I^2=27.89%). This association was examined in three studies (Hall & Long, 2007; Koh et al., 2014; Top et al., 2016).

Associations between paternal perinatal anxiety and the relevant factors

Maternal depression and paternal postnatal anxiety were found to be positively associated in three studies (Koh et al., 2015; Matthey et al., 2003; Vismara et al., 2016). Maternal depression increased the likelihood of paternal postnatal anxiety more than three-fold (OR = 3.86, 95% CI (2.54-5.89), *fig. 4*) with zero heterogeneity. Positive association between paternal prenatal anxiety and maternal depression was also examined in one study (Koh et al., 2015). The factor had an OR = 1.61, 95% CI (1.18-2.19).

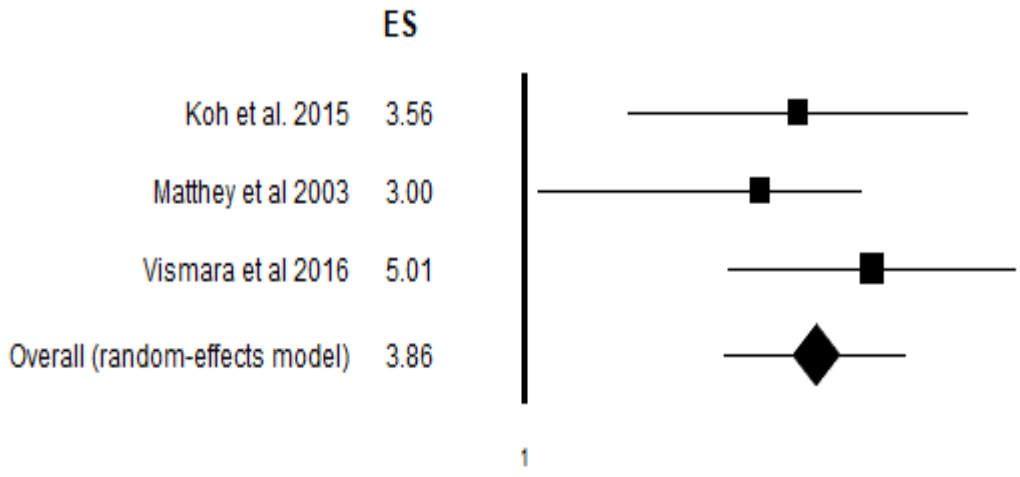

Figure 4 Forest plot of the meta-analysis of risk factor maternal depression for paternal postnatal anxiety

Marital distress and social support were found to be positively associated with paternal perinatal anxiety. One study (Koh et al., 2015) examined the association between marital distress and paternal anxiety in the perinatal period. In the postnatal and prenatal period marital distress increased the likelihood of paternal anxiety more than four-fold with an OR= 4.69, 95% CI (1.73-12.72) and OR= 4.17, 95% CI (2.45-7.10), respectively. Social support and paternal prenatal anxiety were also found to be positively associated and the association was examined in one study (Koh et al., 2015). The factor had an OR = 1.80, 95% CI (1.34-2.42).

Parenting Stress and WFC were also positively associated with paternal prenatal anxiety in the current meta-analysis. Parenting stress increased the likelihood of paternal anxiety in the perinatal period by more than 14-fold (OR = 14.38, 95% CI (7.39-27.97), Vismara et al., 2016). WFC increased the likelihood of paternal prenatal anxiety by more than three-fold (OR = 3.55, 95% CI (2.59-4.87), Koh et al., 2015).

Associations between paternal perinatal anxiety and depression and unique factors

Gender role related stress was found to be a unique factor for, and was positively associated with, paternal depression in the perinatal period. According to Eisler & Skidmore (1987), gender role stress has five factors: physical inadequacy (stress in males related to fears of not being competitive physically); emotional expression (stress in males related to difficulties expressing feelings of affection, fear or pain); intellectual inferiority (stress in males related to their coping abilities); subordination to women (stress in males due to perceived competitive threat from women); and performance failure (stress in males related to potential failure to perform up to masculine standards in the areas of work and sexual adequacy) (Eisler & Skidmore, 1987). In the current meta-analysis, aspects of gender roles were only reported by Buist et al. 2002, finding positive associations between paternal

postnatal depression and perceived physical inadequacy (OR = 3.55, 95% CI (2.59-4.87)), emotional expression (OR=10.33, 95% CI (2.96-36.04)), and intellectual inferiority (OR = 5.29, 95% CI (1.54-18.22)). The gender role related stress was also positively associated with paternal depression in the prenatal period. This positive association was examined in two studies (Buist et al., 2002; Morse et al., 2000). Reported associations included emotional expression (OR = 3.04, 95% CI (1.21-7.64), with substantial heterogeneity (I^2= 64.33%)); subordination to women (OR = 2.03, 95% CI (1.02-4.02), with low heterogeneity (I^2=37%)); intellectual inferiority (OR = 3.33, 95% CI (1.31-8.49), with substantial heterogeneity (I^2=65.31%)); and performance failure (OR = 4.59, 95% CI (1.60-13.20), with substantial heterogeneity (I^2=72.54%)). An overall meta-analysis of all of the factors of gender role stress estimated that postnatally the risk of paternal depression increased more than four-fold (OR= 4.66, 95% CI (2.14-10.15), *fig. 5*). Meanwhile, the risk of prenatal paternal depression increased more than three-fold (OR= 3.12, 95% CI (2.07-4.69), *fig. 6*) with medium heterogeneity (I^2= 54.80%).

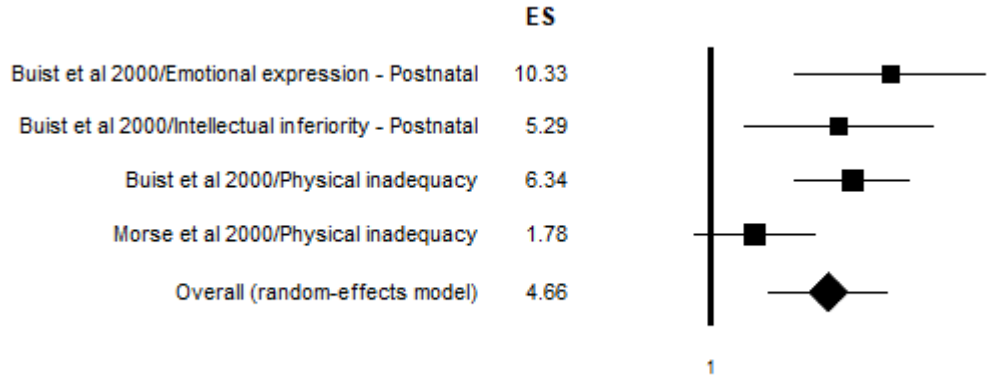

Figure 5 Forest plot of the meta-analysis of risk factor gender role stress for paternal postnatal depression

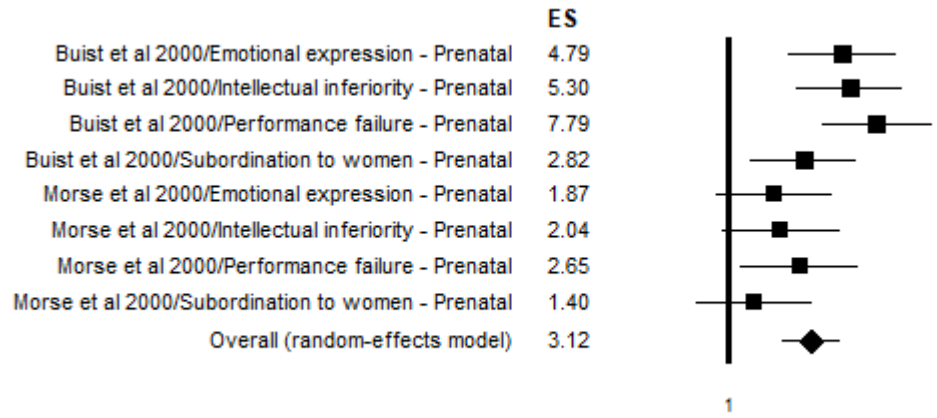

Figure 6 Forest plot of the meta-analysis of risk factor gender role stress for paternal prenatal depression

Mismatched expectations from pregnancy and childbirth was also found to be positively associated with paternal postnatal depression (Greenhalg et al., 2004). This factor increased the likelihood of paternal postnatal depression three-fold (OR = 3.71, 95% CI (1.55-8.89)).

Domestic abuse experienced by fathers and paternal perinatal depression and anxiety were also positively associated in the current meta-analysis. This factor increased the likelihood of paternal perinatal depression and anxiety nine-fold (OR = 9.64, 95% CI (3.50-26.30)). This association was examined by one study (Fisher et al., 2015).

Summaries of the findings from meta-analysis of risk factors are presented in Table 3.

Table 3 Summary of meta-analysis of risk factors for paternal anxiety and depression in both prenatal and postnatal period

I.D.	Risk Factor	Prenatal Anxiety	Postnatal Anxiety	Prenatal Depression	Postnatal Depression
1.	Socioeconomic Factors b. Low Income	-	-	-	**2.03, 95% CI (1.83-2.25), I^2 = 0%** (Bergström, 2013; Carlberg, 2017; Nath et al., 2016; Zhang et al., 2016)
2.	Maternal Depression	**1.61, 95% CI (1.18-2.19)** (Koh et al., 2015)	**3.86, 95% CI (2.54-5.89), I^2 = 0%** (Koh et al., 2015; Matthey et al., 2003; Vismara et al., 2016)	**1.86, 95% CI (1.24-2.77), I^2 = 0%** (Ballard et al., 1994; Matthey et al., 2000)	**3.34, 95% CI (2.51-4.46), I^2 = 82.74%** (Anding et al., 2016; Areias et al., 1996; Ballard et al., 1994; Bergström, 2013; Bielawska-Batorowicz & Kossakowska-Petrycka, 2006; Carro et al., 1993; Cattaneo et al., 2015; Escribà Agüir & Artacoz, 2011; Field et al., 2006; Gao et al., 2009; Goodman, 2004; Mao et al., 2011; Matthey et al., 2000; Matthey et al., 2003; Nath et al., 2016; Ngai & Ngu, 2015; Nishimura et al., 2015; Pinheiro et al., 2006; Ramchandani et al., 2008; Soliday et al., 1999; Thorpe et al., 1992; Zhang et al., 2016)
3.	Marital Distress	**4.17, 95%CI (2.45-7.10)** (Koh et al., 2015)	**4.69, 95% CI (1.73-12.72)** (Koh et al., 2015)	**3.32, 95% CI (2.19-5.02), I^2 = 46.30%** (Ahlqvist –Björkorth	**2.16, 95% CI (1.47-3.19), I^2 = 97.78%** (Anding et al., 2016; Bergström, 2013;

				et al., 2016; Koh et al., 2014; Leathers & Kelly, 2000; Morse et al., 2000; Top et al., 2016)	Bielawska-Batorowicz & Kossakowska-Petrycka, 2006; Buist et al., 2002; Condon et al., 2004; deMontigny et al., 2013; Dudley et al., 2001; Escribà -Agüir & Artacoz, 2011; Gawlik et al., 2013; Greenhalg et al., 2000; Leathers & Kelly, 2000; Nath et al., 2016; Nishimura et al., 2015; Roubinov et al., 2013, Top et al., 2016)
4.	Social Support	**1.80, 95% CI (1.34-2.42)** (Koh et al., 2015)	-	**3.71, 95% CI (2.19-6.28), I^2 =0%** (Koh et al., 2014; Wee et al., 2015)	**4.76, 95% CI (1.04-21.73), I^2 = 91.33%** (Gao et al., 2009; Mao et al., 2011; Wang et al., 2006)
5.	Prenatal Depression	-	-	-	**5.20, 95% CI (3.13-8.65), I^2 = 75.07%** (Escribà-Agüir & Artacoz, 2011; Gawlik et al., 2013; Hall & Long, 2007; Koh et al., 2014; Matthey et al., 2000; Ngai & Ngu, 2015; Ramchandani et al., 2008; Soliday et al., 1999; Suto et al., 2016)
6.	History of Psychiatric Illness	-	-	-	**3.30, 95% CI(1.95-5.57), I^2 = 87.36%** (Areias, 1996; Bronte-Tinkew et al., 2007; Cattaneo et al., 2015; Nishimura & Ohashi, 2010; Nishimura et al., 2015;

					Ramchandani et al., 2008; Suto et al, 2016)
7.	Alcohol Abuse	-	-	-	**2.40, 95% CI (1.86-3.29), I^2 = 0%** (Bronte-Tinkew et al., 2007; Condon et al., 2004; Pinheiro et al., 2006)
8.	Unplanned Pregnancy	**4.22, 95% CI (1.6-11.3)** (Fisher et al., 2012)	-	**2.68, 95% CI (1.10-6.55)** (Top et al., 2016)	**3.34, 95% CI (2.13-5.23), I^2 = 0%** (Fisher et al., 2012; Gao et al, 2009; Nishimura & Ohashi, 2010; Top et al., 2016)
9.	Parenting Stress	**14.38, 95% CI (7.39-27.97)** (Vismara et al., 2016)	-	-	**3.04, 95% CI (1.07-8.64), I^2 = 92.88%** (deMontigny et al., 2013; Soliday et al., 1999; Vismara et al., 2016; Zhang et al., 2016)
10.	Preference for a Male Baby	-	-	-	**1.5, 95% CI (1.04-2.38), I^2 = 0%** (Gao et al., 2009; Mao et al., 2011)
11.	Work-Family Conflict	**3.55, 95% CI (2.59-4.87)** (Koh et al., 2015)	-	**3.53. 95% CI (2.01-6.23), I^2 = 27.89%** (Hall & Long, 2007; Koh et al., 2014; Top et al., 2016)	**4.85, 95% CI (1.51-15.59)** (Koh et al., 2014)
12.	Perceived Stress	-	-	-	**7.51, 95% CI (1.14-49.52), I^2 = 95.92%** (Gao et al., 2009; Kamalifard et al., 2014; Mao et al., 2011)
13.	Gender Role Stress a. Physical Inadequacy	-	-	-	**3.55, 95% CI (2.59-4.87)** (Buist et al., 2002)

	b. Emotional Expression	-	-	**3.04, 95% CI (1.21-7.64), I^2 =64.33%** (Buist et al., 2002; Morse et al., 2000)	**10.33, 95% CI (2.96-36.04)** (Buist et al., 2002)
	c. Subordination to Women	-	-	**2.03, 95% CI (1.02-4.02), I^2 = 37%** (Buist et al., 2002; Morse et al., 2000)	-
	d. Intellectual Inferiority	-	-	**3.33, 95% CI (1.31-8.49), I^2 = 65.31%** (Buist et al., 2002; Morse et al., 2000)	**5.29, 95% CI (1.54-18.22)** (Buist et al., 2002)
	e. Performance Failure	-	-	**4.59, 95% CI (1.60-13.20), I^2 = 72.54%** (Buist et al., 2002; Morse et al., 2000)	-
14.	Mismatched Expectations from Pregnancy and Childbirth	-	-	-	**3.71, 95% CI (1.55-8.89)** (Greenhalg et al., 2004)
15.	Domestic Violence	**9.64, 95% CI (3.5-26.3)** (Fisher et al., 2012)			

Note: The estimated effect size is reported in Odds Ratio (OR); CI = Confidence Interval

Discussion

This article reports a systematic review of 45 studies with a combined sample size of 31,310 fathers. Twelve risk factors for paternal perinatal depression were identified: low income, maternal depression, marital conflict, social support, prenatal depression, history of psychiatric illness, alcohol abuse, unplanned pregnancy, parenting stress, preference for a male baby, work family conflict (WFC), and perceived stress. Five risk factors were reported for perinatal anxiety in fathers: maternal depression, marital conflict, social support, WFC, and parental stress. Three risk factors (gender role related stress, mismatched expectations from pregnancy and childbirth, and domestic violence) and their associations with paternal perinatal depression and anxiety were found to be unique to fathers only. Each risk factor and its associations were examined individually and separate meta-analyses were conducted for each risk factor for depression and anxiety respectively.

Using OR to determine effect size, a large effect size (OR>5) was observed for perceived stress and prenatal depression concurring higher risk of depression in the postnatal period amongst fathers. A medium effect size (OR≥2) was seen for the risk factors low income, maternal depression, marital distress, social support, history of psychiatric illness, alcohol abuse, parenting stress, and WFC in the postnatal period. In the prenatal period, marital distress, social support, unplanned pregnancy, and WFC had a medium effect size. A small effect size (OR<2) was observed for the preference for a male baby in the postnatal period and maternal depression in the prenatal period.

Perceived stress is the feelings or thoughts of how much stress an individual is under at a given point in time or over a period of time (Cohen, Kamarck, & Mermelstein, 1983). Having a baby is most likely to add new responsibilities and stress on new fathers, such as financial stress and stress related to parenting. Along with the addition of new

responsibilities, fathers may also experience changes in their lifestyle and habits which may further add to their experience of stress. The continuous sense of stress within all sectors of a fathers' life may cause them to feel melancholic and lead to depression in the prenatal period (Mao, Zhu & Su, 2011). Concurrently, if the father is feeling depressed in the prenatal period, the stressors related to childbirth and a new baby may aggravate the symptoms of depression in the postnatal period (Matthey et al., 2000). The result of the current meta-analysis supports the findings by Cohen et al. (1983) and Matthey et al. (2000), where a strong association between paternal postnatal depression and the risk factors of perceived stress and prenatal depression was seen.

Although perceived stress and prenatal depression had the largest effect size on paternal postnatal depression, studies examining the association between maternal depression (n=22) and paternal postnatal depression, and marital distress/conflict (n=15) and paternal postnatal depression were the statistical relationships most frequently reported. Maternal mental health during the perinatal period is an important risk factor for the mother and the mental health, physical health, and behaviour of the infant (Beydoun & Saftlas, 2008). Simultaneously, an interactive relationship between the mental health of the fathers and mothers has also been noted previously (Matthey et al., 2000; Pinheiro et al., 2006). Having a depressed partner increases the risk of fathers to be depressed themselves in the perinatal period at a rate of 2.5 times or higher (Matthey et al., 2000; Pinheiro et al., 2006). Fathers with depressed partners are also likely to experience conflict or distress in their marital relationship. With their partner being depressed, it is possible that fathers are unable to communicate the difficulties and experiences they are facing to their partner. Many factors are likely to be inter-connected. For example, depressed mothers might not be able to take care of their infant, which may further put new fathers under pressure and thus cause them stress. Maternal depression alone, and/or diminished care for the infant may also negatively

contribute towards a worsening marital relationship between mother and father. This in turn may cause distress for fathers, which may lead to depression.

As previously mentioned, fathers may also suffer from financial stress after having a baby. This stress is more likely to occur in fathers belonging to a lower socio-economic group who earn a below average salary. An unplanned pregnancy may be stressful to the father because they did not have sufficient time to prepare for taking care of an infant. Lack of planning may occur across several emotional or financial domains, which may be independent or exacerbate each other leading to depression in the perinatal period. Financial stress may also interact with perceived gender role. Fathers are often viewed as being the main provider of the family (Buist et al., 2003). Inability to fulfil this role may cause distress in fathers through a perception of their personal inadequacy or their perception that they are not meeting the expectations of other males. Similarly, to the stress related to finances, fathers may also experience parenting stress. If the father has no previous experience of parenting, he may become uncertain, stressed, and overwhelmed and may seek assistance and support from his partner. Men tend to have a poorer social support system compared to women because men tend to rely primarily on their partner for social support (Cronenwett & Kunst-Wilson 1981). However, if the father is unable to receive this support from his partner because his partner is depressed, this may cause him distress and may cause depression in the father. Again, these risk factors are likely to be highly interactive: dissatisfaction from the paternal role may be related to increase parenting stress, both making paternal depression more likely. Another domain commonly affected is work. Demanding and strained situations and responsibilities at home and fathers' own mental health may also affect their work and interaction with their colleagues. Again, gender role stress may play a contributing factor to WFC. Masculine gender norms suggest that men are expected to be competitive and excel in their work (Good, Dell, & Mintz, 1989). However, inability to achieve their best at work due

to poor perinatal mental health may cause work-family conflict and further contribute towards the deteriorating mental state of the father (Koh et al., 2014).

Fathers may also experience depression in the perinatal period if they have a history of a psychiatric disorder. Life events such as pregnancy and childbirth may exacerbate the symptoms of previous psychiatric illness and affect the mental health of fathers during the perinatal period. Alcohol abuse and paternal postnatal depression were also found to be positively correlated in this meta-analysis. Research suggests that alcohol abuse and depression commonly co-exist in men (Zilberman, Tavares, Blume, & el-Guebaly, 2003) and that individuals with alcoholism are at a two-times higher risk for depression (National Institute of Mental Health [NIMH], 2003). The alcohol-depression interaction is complex. Possibilities include self-medication of depressive symptoms with alcohol or alcohol directly causing low mood. Alcohol abuse may have been used to mask the symptoms of depression (Cochran & Rabinowitz, 2000). In these scenarios, alcohol abuse may be considered as an underlying symptom of depression. Finally, fathers' mental health may also be affected by their cultural expectations. For example, in many Asian cultures there is a preference for a male baby as he is expected to carry the family name and care for his aged parents (Koh et al., 2014). If the fathers do not have a male baby, they may suffer from depression in these cultures. This was also noted in the results of the current meta-analysis as the factor of preference for a male baby had a small effect size on paternal perinatal depression. However, as mentioned previously, there is a lack of studies on paternal perinatal depression in non-Western countries and thus, this risk factor should be explored further.

When considering paternal anxiety, a large effect size was observed for parenting stress in the prenatal period for paternal anxiety. A medium effect size was observed for maternal depression, marital conflict, and social support in the postnatal period while WFC expressed a medium sized effect in the prenatal period for paternal anxiety. A small effect

size was seen for maternal depression and social support in the prenatal period for paternal anxiety.

Similar to depression, fathers are more likely to develop anxiety during the perinatal period if they are a new father and have not taken care of a baby previously. They are more likely to be uncertain, distressed, and unsure of how to take care of the baby and may seek assistance from their partner. If the father is not able to receive this guidance, it may cause them distress and possible anxiety in the perinatal period. Fathers are less likely to receive this guidance and support from their partner if their partner is suffering from depression themselves during the perinatal period (Koh et al., 2015). Moreover, this may also affect the social support system of the father. As mentioned earlier, men tend to rely heavily on their partner for social support (Cronenwett & Kunst-Wilson, 1981) and if this support is missing, it may lead to anxiety in the father. As with the previous discussion about paternal depression, these risk factors are likely to be inter-related. Lack of social support and a partner's depression may contribute to marital conflict and thus further deteriorate the father's mental health. Financial stress may require longer hours at work, a deterioration of work-family balance, and put fathers at higher risk of anxiety in the perinatal period. Also, similar to paternal depression, gender role conflict may contribute towards the above-mentioned risk factors and cause further distress leading to perinatal anxiety in fathers. It should be noted that the associations between perinatal anxiety and the factors mentioned were examined in only three studies and thus should be interpreted with caution, and require further study.

This analysis reported some risk factors which were unique to fathers, and were associated with fathers' depression and anxiety in the perinatal period. Unique risk factors such as low emotional expression in men had a large effect size and increased the likelihood of paternal postnatal depression. A medium effect size was seen for a father's perception of

physical inadequacy. In the prenatal period, low emotional expression, feelings of subordination to women, intellectual inferiority, and performance failure factors had a medium effect size. These factors clearly relate to the concept of masculine gender norms. Low emotional expression is often considered as behaviour of a 'typical male'. Consequently, men may fear a negative response from their peers if they share their symptoms or experience of depression (Joiner, Alfano, & Metalsky, 1992). Physical toughness and the emphasis of power over women are consistent with masculine norms, and may precipitate concerns of being unable to perform to masculine standards in the arenas of work and sexual adequacy. These masculine norms can offer an explanation of why perceptions of physical inadequacy, subordination to women, intellectual inferiority, and performance failure are unique risk factors for fathers' perinatal depression and anxiety (Buist et al., 2003). The findings add value to the existing literature where positive correlations have been demonstrated between masculine gender role conflict and elevated scores on self-report depression measures (Magovcevic & Addis, 2005; Shepard, 2002).

Domestic violence towards fathers was also identified as a factor unique to men, and had a large effect size in paternal perinatal depression and anxiety. Domestic violence also known as Intimate Partner Violence (IPV) may be described as a pattern of abusive behaviours of one or both partners in an intimate relationship (Drijber, Reijnders, & Ceelen, 2013). As mentioned before, one of the many masculine gender norms is power and control over women. The Duluth Model (Pence & Paymar, 1983) exemplifies this norm by stating domestic violence is a matter of power and control, of which only men in a system of patriarchy are capable (Hines & Douglas, 2009), which rules out the possibility of men experiencing domestic violence committed by their partners. Thus, men who experience domestic violence may feel embarrassed, a fear of being ridiculed, and as a result are less likely to seek help (McNeely, Cook & Torres, 2001). Even if they overcome this internal

barrier, an external barrier is the availability of limited resources that specifically cater to men (Hines & Douglas, 2009). Existing literature has reported that men who experience domestic violence also experience greater levels of depression, stress, and other psychological and psychosomatic symptoms (Coker et al., 2002). This finding was replicated in the current meta-analysis where domestic violence against fathers correlated positively with perinatal depression. This risk factor challenges the common understanding that domestic violence is exclusively perpetrated by men against women.

A father's mismatched expectations from pregnancy and childbirth had a medium effect size, and is a unique factor for paternal depression the postnatal period. During pregnancy, women are the ones who experience changes in their hormones and physical bodies and are able to feel the movement of the baby (Donaldson-Myles, 2012). Fathers could be considered as the 'outsiders' to this process, and are perhaps unable to comprehend the complexity of pregnancy and childbirth. Furthermore, their expectations as a parent during the pregnancy period might not match the reality after their children are born. Also, current resources on pregnancy, childbirth, and parenting are mainly oriented towards mothers with a clear lack of information for fathers (Greenhalg et al., 2004). However, during the labour and after childbirth, fathers are expected to play a more active role in caring for and parenting of the new born (Greenhalg et al., 2004). The lack of resources and experience in parenting may cause an inconsistency between the expectations from pregnancy and childbirth for fathers in the postnatal period. This also challenges the masculine gender norms as fathers may have to ask for help from their partner, and they may question their rational coping abilities, their decision-making capabilities, and their intellectual capability to handle a situation associated with parenting (Morse et al., 2000).

It is important to note that available data for comparison and evaluation of the above-mentioned unique factors is minimal, and requires further study. Similar to anxiety, the

unique risk factors included in this meta-analysis have been examined in one or two studies only. This limits the interpretation and conclusions that can be drawn about these risk factors but at the same time highlights the areas that warrant further investigation.

This systematic review and meta-analysis provides empirical evidence about the risk factors associated with paternal perinatal mental health; however there are limitations. First, studies used varying measuring methods and cut off scores. This lack of standardisation of both risk factors and outcome variables associated with paternal perinatal mental health makes interpretation of results across studies difficult. Second, the review is populated by cross-sectional studies. The limited number of longitudinal studies included in this review restricts the ability to comment on causation or the relative strength of risk factor over time that is from prenatal to postnatal period. Third, the majority of the studies used self-report measures to quantify the risk factors associated with paternal perinatal mental health. This makes both over- and under-exaggeration of the symptoms and risk factors a possibility. Last, it should also be noted that a number of studies were excluded from the review due to stringent inclusion/exclusion criteria such as teen fathers, fathers with infants in Natal Care Intensive Unit (NCIU), previous loss of an infant and fathers with an infant suffering from illness. Studies were also excluded if the information about the reported risk factors was insufficient or if the contacted authors failed to respond.

Despite the limitations, the systematic review and meta-analysis is strengthened by the clear use of gold standard PRISMA guidelines, providing a clear and transparent view into how the data was collected and analysed, and allows replication of the data for future studies. The results of multiple statistically significant associations between the risk factors and paternal depression and anxiety in the perinatal period suggests the need for further research. This study provides preliminary evidence of the importance of screening fathers, especially if their partner is diagnosed with depression and/or anxiety. This study also brings

into focus the potential risk of masculine gender role stress for contributing to perinatal mental health concerns for fathers. The interaction of this with some of the other risk factors identified also requires further study. Healthcare professionals should also be aware that fathers who adhere to traditional gender norms may have negative attitudes towards help-seeking, and are at risk of being underdiagnosed or misdiagnosed. Interventions based on these risk factors may help reduce the prevalence of depression and anxiety in fathers in the perinatal period.

References

Addis, M. E. (2008). Gender and depression in men. *Clinical Psychology:Science and Practice, 15*(3), 153-168. doi: DOI 10.1111/j.1468-2850.2008.00125.x

Addis, M. E., & Cohane, G. H. (2005). Social scientific paradigms of masculinity and their implications for research and practice in men's mental health. *Journal of Clinical Psychology, 61,* 1-15.

American Psychiatric Association. (2018). *Diagnostic and Statistical Manual of Mental Disorders: DSM-5* (5th ed.). Washington DC: Arlington, VA.

Ahlqvist-Björkorth, S., Korja, R., Junttila, N., Savonlahti, E., Pajulo, M., Räihä, H., & The Steps Study Group. (2016). Mothers' and fathers'prenatal representations in relation to marital distress and depressive symptoms. *Infant Mental Health Journal, 37*(4), 388-400. Doi: 10.1002/imhg.21578

Anding, J. E., Röhrle, B., Grieshop, M., Schücking, B., & Christiansen, H. (2016). Couple comorbidity and correlates of postnatal depressive symptoms in mothers and fathers in the first two weeks following delivery. *Journal of Affective Disorder, 190,* 300-309. Doi: 10.1016/j.jad.2015.10.033

Areias, M., Kumar, R., Barros, H. and Figuerido, E. (1996). Correlates of Postnatal Depression in Mothers and Fathers. *Br J Psychiatry, 169*, 36-41.

Azad, R., Fahmi, R., Shrestha, S., Joshi, H., Hasan, M., Khan, A. N. S., Billah, Sk. M. (2019). Prevalence and risk factors of postpartum depression within one year after birth in urban slums of Dhaka, Bangladesh. *PLos One, 14*(5): e0215735. Doi: 10.1371/journal.pone.0215735

Ballard, C. G., Davis, R., Cullen, P. C., Mohan, R. N., & Dean, C. (1994). Prevalence of postnatal psychiatric morbidity in mothers and fathers. *Br J Psychiatry, 164*(6), 782-788.

Bergström, M. (2013). Depressive symptoms in new first-time fathers: associations with age, sociodemographic characteristics, and antenatal psychological well-being. *Birth, 40*(1), 32-38. doi:10.1111/birt.12026

Beydoun, H., & Saftlas, A. F. (2008). Physical and mental health outcomes of prenatal maternal stress in human and animal studies: a review of recent evidence. *Paediatr Perinat Epidemiol, 22*(5), 438-466. doi:10.1111/j.1365-3016.2008.00951.x

Bielawska-Batorowicz, E., & Kossakowska-Petrycka, K. (2006). Depressive mood in men after the birth of their offspring in relation to a partner's depression, social support, fathers' personality and prenatal expectations. *Journal of Reproductive and Infant Psychology, 24*(1), 21-29. doi:10.1080/02646830500475179

Boyce, P., Condon, J., Barton, J., & Corkindale, C. (2007). First-Time Fathers' Study: psychological distress in expectant fathers during pregnancy. *Aust N Z J Psychiatry, 41*(9), 718-725. doi:10.1080/00048670701517959

Bradley, R., Slade, P., & Leviston, A. (2008). Low rates of PTSD in men attending childbirth: A preliminary study. *British Journal of Clinical Psychology, 47,* 295-302. Doi: 10.1348/014466508X279495

Bronte-Tinkew, J., Moore, K. A., Matthews, G. and Carrano, J. (2007). Symptoms of Major Depression in a Sample of Fathers of Infants. *Journal of Family Issues, 28*(1), 61-99. Doi: 10.117/0192513X06293609

Buist, A., Morse, C. A., & Durkin, S. (2003). Men's adjustment to fatherhood: implications for obstetric health care. *J Obstet Gynecol Neonatal Nurs, 32*(2), 172-180. doi:10.1177/0884217503252127

Cameron, E. E., Sedov, I. D., & Tomfohr-Madsen, L. M. (2016). Prevalence of paternal depression in pregnancy and the postpartum: An updated meta-analysis. *J Affect Disord, 206*, 189-203. doi:10.1016/j.jad.2016.07.044

Carlberg, M., Edhborg, M., & Lindberg, L. (2018). Paternal Perinatal Depression Assessed by the Edinburgh Postnatal Depression Scale and the Gotland Male Depression Scale: Prevalence and Possible Risk Factors. *Am J Mens Health, 12*(4), 720-729. doi:10.1177/1557988317749071

Carro, M. G., Grant, K. E., Gotlib, I. H., & Compas, B. E. (1993). Postpartum depression and child development: An investigation of mothers and fathers as sources of risk and resilience. *Dev psychopathol, 5*, 567-579.

Carter. J. D., Mulder R. T., Bartram, A. F., & Darlow, B. A. (2005). Infants in a neonatal intensive care unit: parental response. *Arch Dis Child Fetal Neonatal Ed, 90*, 109-113. Doi: 10.1136/adc.203.031641

Cattaneo, M. C., Macchi, E. A., Salerno, R., Chiorino, V., Roveraro, S., Barretta, F., & Mosca, F. (2015). Prevalence of paternal perinatal depressive mood and its relationship with maternal depression symptomatology: An Italian study. *Int J Adv Nurs Stud, 4*(2), 103.

Centre of Perinatal Excellence (COPE). (2017). *National Perinatal Mental Health Guideline.*

Cochran, S. V., & Rabinowitz, F. E. (2000). *Men and depression:Clinical and empirical perspectives.* San Diego, CA: Academic Press.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*, 385–396.

Coker, A. L., Davis, K. E., Areias, I., Desai, S., Sanderson, M., Brandt, H. M., & Smith, P. H. (2002). Physical and mental health affects of intimate partner violence for men and women. *American Journal of Preventive Medicine, 23*(4), 260-268.

Condon, J. T., Boyce, P., & Corkindale, C. J. (2004). The First-Time Fathers Study: A prospective study of the mental health and wellbeing of men during the transition to parenthood. *Aust N Z J Psychiatry, 38*(1-2), 56-64. doi:10.1177/000486740403800102

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry, 150*, 782-786.

Cronenwett, L. R., & Kunst-Wilson, W. (1981). Stress, social support, and the transition to fatherhood. *Nurs Res, 30*(4), 198-201.

deMontigny, F., Girard, M.-E., Lacharitè, C., Dubeau, D., & Devault, A. (2013). Psychosocial factors associated with paternal postnatal depression. *J Affect Disorde, 150*, 44-49.

Drijber, B. C., Reijnders, U. J. L., & Ceelen, M. (2013). Male victims of domestic violence. *J Fam Viol, 28,* 173-178. Doi: 10.1007/s10896-012-9482-9.

Donaldson-Myles, F. (2012). Can hormones in breastfeeding protect against postnatal depression? *British Journal of Midwifery, 20*(2), 88-93.

Dudley, M., Roy, K., Kelk, N., & Bernard, D. (2001). Psychological correlates of depression in fathers and mothers in the first postnatal year. *Journal of Reproductive and Infant Psychology, 19*(3), 187-202. doi:10.1080/02646830124397

Edoka, I. P., Petrou, S., & Ramchandani, P. G. (2011). Healthcare costs of paternal depression in the postnatal period. *J Affect Disord, 133*(1-2), 356-360. doi:10.1016/j.jad.2011.04.005

Escribà-Agüir, V., & Artazcoz, L. (2011). Gender differences in postpartum depression: A longitudinal cohort study. *J Epidemiol Community Health, 65,* 320-326.

Eisler, R. M., & Skidmore, J. R. (1987). Masculine gender role stress: Scale development and component factors in the appraisal of stressful situations. *Behavioural Medicine, 11*(2), 123-136.

Fiala, A., Švancara, J., Klánová, J., & Kaśpárek, T. (2017). Sociodemographic and delivery risk factors for developing postpartum depression in a sample of 3233 mothers from the Czech ELSPAC study. *BMC Psychiatry 17*(104).

Field, T., Diego, M., Hernandez-Reif, m., Figueiredo, B., Deed, O., Contogeorgo, J., & Ascencio, A. (2006). Prenatal paternal depression. *Infant Behav dev, 29*(4), 579-583.

Figueiredo, B., & Conde, A. (2011). Anxiety and depression in women and men from early pregnancy to 3-month postpartum. *Arch Womens ment Health, 14,* 247-255. Doi: 10.1007/s00737-011-0217-3

Fisher, J., Tran, T. D., Nguyen, T. T., & Tran, T. (2012). Common perinatal mental disorders and alcohol dependence in men in Northern Vietnam. *Journal of Affective Disorders, 140,* 97-101. Doi: 10.1016/j.jad.2012.03.029.

Gao, L. L., Chan, S. W., & Mao, Q. (2009). Depression, perceived stress, and social support among first-time Chinese mothers and fathers in the postpartum period. *Res Nurs Health, 32*(1), 50-58. doi:10.1002/nur.20306

Gavin, N. I., Gaynes, B. N., Lohr, K. N., Meltzer-Brody, S., Gartlehner, G., & Swinson, T. (2005). Perinatal depression: a systematic review of prevalence and incidence. *Obstet Gynecol, 106*(5 Pt 1), 1071-1083. doi:10.1097/01.AOG.0000183597.31630.db

Gaynes, B. N., Gavin, N., Meltzer-Brody, S., Lohr, K. N., Swinson, T., Gartlehner, G., . . . Miller, W. C. (2005). Perinatal depression: prevalence, screening accuracy, and screening outcomes. *Evid Rep Technol Assess (Summ)*(119), 1-8.

Gawlik, S., Müller, M., Hoffman. L., Dienes, A., Wallwiener, M., Sohn, C., Schele, B. & Reck, C. (2014). Prevalence of paternal perinatal depressivebess abd its link to aprtnership satisfaction and birth concerns. *Arch Womens Ment Health, 17,* 49-56. Doi: 10.1007/s00737-013-0377-4.

Giallo, R., D'Esposito, F., Christensen, D., Mensah, F., Cooklin, A., Wade, C., . . . Nicholson, J. M. (2012). Father mental health during the early parenting period: results of an

Australian population based longitudinal study. *Soc Psychiatry Psychiatr Epidemiol, 47*(12), 1907-1916. doi:10.1007/s00127-012-0510-0

Good, G. E., Dell, D. E., & Mintz, L. B. (1989). Male role and gender role conflict: Relations to help seeking in men. *Journal of Counselling and Development, 74*, 70-75.

Goodman, J. H. (2004). Paternal postpartum depression, its relationship to maternal postpartum depression, and implications for family health. *J Adv Nurs, 45*(1), 26-35.

Greenhalg, R., Slade, P., & Spiby, H. (2000). Fathers' coping style, antenatal preparation, and experiences of labor and postpartum. *Birth, 27*(30), 177-184.

Hall, W. A., & Long, B. C. (2007). Relations among prenatal role quality, life satisfaction, and dual-earner parents' postnatal depression. *Journal of Prenatal and Perinatal Psychology and Health, 21*(3).

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine, 21,* 1539-1558.

Hines, D. A., & Douglas, E. M. (2009). Women's use of intimate partner violence against men: prevalence, implications and consequences. *Journal of Aggression, Maltreatment & Trauma, 18*(6), 572-586.

Hoogendoorn, W. E., van Poppel, M. N., Bongers, P. M., Koes, B. W., & Bouter, L. M. (2000). Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine, 25*(16), 2114-2125.

Hutton, B., Salanti, G., Caldwell, D. M., Chaimani, A., Schmid, C. H., Moher, D. (2015). The PRISMA extension statement for reporting of systematic reviews incorporating network meta-analyses of health care interventions: checklist and explanations. *Ann Intern Med, 162*(11), 777-784. Doi: 10.7326/M14-2385

Joiner, T. E., Alfano, M. S., & Metalsky, G. I. (1992). When depression breeds contempt: Reassurance seeking, self-esteem, and rejection of depressed college students by their roommates. *American Psychological Association, 101,* 165-173.

Kamalifard, M., Hasanpoor, S., Kheiroddin, J. B., Panahi, S., & Payan, S. B. (2014). Relationship between fathers' depression and perceived social support and stress in postpartum period. *Journal of Caring Sciences, 3*(1), 57-66. Doi: 10.5681/jcs.2014.007.

Koh, Y. W., Chi, C. Y., Tang, C. S. K., & Lee, A. M. (2014). The prevalence and risk factors of paternal depression from the antenatal to the postpartum period and the relationships between antenatal and postpartum depression among fathers in HongKong. *Depression Research and Treatment.* Doi: 10.1155/2014/127632

Koh, Y. W., Lee. A. M., Chan, C. Y., Fong, D. Y. T., Lee, C. P., Leung, K. Y., & Tang, C. S. K. (2015). Survey on examining prevalence of paternal anxiety and its risk factors in perinatal perios in Hong Kong: A longitudinal study. *BMC Public Health, 15* (1131). Doi: 10.1186/s12889-015-2436-4

Lancaster, C. A., Gold, K. J., Flynn, H. A., Yoo, H., Marcus, S. M., Davis, M. M. (2010). Risk factors for depressive symptoms during pregnancy: a systematic review. *Am J Obstet Gynecol, 202,* 5-14. Doi: 10.1016/j.ajog.2009.09.007

Leach, L. S., Poyser, C., Cooklin, A. R., & Giallo, R. (2016). Prevalence and course of anxiety disorders (and symptom levels) in men across the perinatal period: A systematic review. *J Affect Disord, 190,* 675-686. doi:10.1016/j.jad.2015.09.063

Leach, L. S., Poyser, C., & Fairweather-Schmidt, K. (2017). Maternal perinatal anxiety: A review of prevalence and correlates. *Clinical Psychologist, 21*(1), 4-19.

Leathers, S. J., & Kelley, M. A. (2000). Unintended pregnancy and depressive symptoms among first-time mothers and fathers. *Am J Orthopsychiatry, 70* (4), 523-531.

Magovcevic, M., & Addis, M. E. (2005). Linking gender role conflict to non-normative and self-stigmatizing perceptions of alcohol abuse and depression. *Psychology of Men and Masculinity, 6,*127-136.

Mao, Q., Zhu, L., & Su, X. (2011). A comparison od postnatal depression and related factors between Chinese new mothers and fathers. *Journal of Clinical Nursing, 20*(5/6), 645-652. Doi: 10.1111/j.1365-2702. 2010.03542.x.

Marcus, M., Yasamy, M. T., van Ommeren, M. V., Chisholm, D., & Saxena, S. (2012). *Depression: A global public health concern*. World Federation of Mental Health World Health Organisation: Perth, Australia, 2012.

Marston, L. (2010). *Introductory statistics for health and nursing using SPSS*. Thousand Oaks, California: Sage Publications, Ltd.

Matthey, S., Barnett, B., Ungerer, J., & Waters, B. (2000). Paternal and maternal depressed mood during the transition to parenthood. *J Affect Disord, 60*(2), 75-85.

Matthey, S., Barnett, B., Kavanaugh, D. J. (2003). Diagnosing postpartum depression in moters and fathers: Whatever happened to anxiety? *Journl of Affective Disorders, 74*(2), 139-147.

McLearn, K. T., Minkovitz, C. S., Strobino, D. M., Marks, E., & Hou, W. (2006). The timing of maternal depressive symptoms and mothers' parenting practices with young children: implications for pediatric practice. *Pediatrics, 118*(1). Doi: 10.1542/peds/.2005-1551.

McNeely, R. L., Cook, P. W. & Torres, J. B. (2001). Is domestic violence a gender issue, or a human issue? *Journal of Human Behaviour in the Social Environment, 4*, 227-251.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. (2015). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med, 151*(4), 264-269. Doi: 10.7326/0003-4819-151-4-200908180-00135

Morse, C. A., Buist, A., & Durkin, S. (2000). First-time parenthood: Influences on pre- and postnatal adjustment in fathers and mothers. *Journal of Psychosomatic Obstetrics & Gynecology, 21*(2), 109-120. doi:10.3109/01674820009075616

Nath, S., Psychogiou, L., Kuyken, W., Ford, T., Ryan, E., & Russell, G. (2016). The prevalence of depressive symptoms among fathers and associated risk factors during the first seven years of their child's life: findings from the Millennium Cohort Study. *BMC Public Health, 16,* 509. doi:10.1186/s12889-016-3168-9

National Institute of Mental Health. (2003). *Men and Depression* (NIH 03-4972).

Ngai, F-W., & Ngu, S-F. (2015). Predictors of maternal and paternal depressive symptoms at postpartum. *Journal of Psychosomatic Research, 78,* 156-161. Doi: 10.1016/j.psychores.2014.12.003

Nishimura, A., & Ohashi, K. (2010). Risk factors of paternal depression in the early postnatal period in Japan. *Nurs Health Sci, 12*(2), 170-176. doi:10.1111/j.1442-2018.2010.00513.x

Nishimura, A., Fujita, Y., Katsuta, M., Ishihara, A., & Ohashi, K. (2015). Paternal postnatal depression in Japan: an investigation of correlated factors including relationship with a partner. *BMC Pregnancy & Childbirth, 15*(128). Doi: 10.1186/s12884-015-0552-x

O'Brien, A. P., McNeil, K. A., Fletcher, R., Conrad, A., Wilson, A. J., Jones, D., & Chan, S. W. (2017). New fathers' perinatal depression and anxiety-treatment options: An integrative review. *Am J Mens Health, 11*(4), 863-876. doi:10.1177/1557988316669047

Pace, R., Pluye, P., Bartlett, G., Macaulay, A. C., Salsberg, J., Jagosh, J., & Seller, R. (2012). Testing the reliability and efficiency of the pilot Mixed Methods Appraisal Tool (MMAT) for systematic mixed studies review. *International Journal of Nusrsing Studies, 49*(1), 47-53. Doi: 10.1016/j.ijnurstu.2011.07.002

Paulson, J. F., & Bazemore, S. D. (2010). Prenatal and Postpartum Depression in Fathers and Mothers Reply. *Jama-Journal of the American Medical Association, 304*(9), 961-962. doi:10.1001/jama.2010.1239

Pence, E., & Paymar, M. (1983). *Education groups of men who batter: The Duluth Model.* New York: Springer.

Pinheiro., R. T., Magalhaes, P. V. S., Horta, B. L., Pinheiro, K. A. T., da Silva, R. A. & Pinto, R. H. (2006). Is paternal postpartum depression associated with maternal postpartum depression? Population-based study in Brazil. *Acta Pyschiatrica Scandinavica, 113*(3), 23-232.

Pinheiro, K. A. T., Coelho, F. M. d-C., Quevedo, L. d-A., Jansen, K., Souza, L. d-M., Oses, J. P., Hota B. L., da Silva, R. A., Pinheiro, R. T. (2011). Paternal postpartum mood: Bipolar episodes? *Revista Brasileira de Psiqueitra, 33*(3), 283-286.

ProMeta (Version 3.0.0) [Computer Software]. Cesena, Italy: Internovi.

Quinlivan, J. A., & Condon, J. (2005). Anxiety and depression in fathers in teenage pregnancy. *Australian & New Zealand Journal of Psychiatry, 39*(10), 915-920. Doi: 10.1080/j.1440-1614.2005.01664.x

Ramchandani, P. G., Stein, A., Evans, J., & O'Connor, T. G. (2005). Paternal depression in the postnatal period and child development: A prospective popultion study. *Lancet, 365*, 2201-2205.

Ramchandani, P. G., Stein, A., O'Connor, T. G., Heron, J., Murray, L., & Evans, J. (2008). Depression in men in the postnatal period and later child psychopathology: a population cohort study. *J Am Acad Child Adolesc Psychiatry, 47*(4), 390-398. doi:10.1097/CHI.0b013e31816429c2

Ramchandani, P. G., Psychogiou, L., Vlachos, H., Iles, J., Sethna, V., Netsi, E., & Lodder, A. (2011). Paternal depression: an examination of its links with father, child and family functioning in the postnatal period. *Depress Anxiety, 28*(6), 471-477. doi:10.1002/da.20814

Roubinov, D. S., Luecken, L. J., Crnic, K. A., & Gonzales, N. A. (2014). Postnatal depression in Mexican American fathers: Demographic, cultural, and familial predictors. *Journal of Affective Disorders,* 152-154.

Shepard, D. S. (2002). A negative state of mind: Patterns of depressive symptoms among men with high gender role conflict. *Psychology of Men and Masculnity, 3*, 3-8.

Soliday, E., McCluskey-Fawcett, K., & O'Brien, M. (1999). Postpartum affect and depressive symptoms in mothers and fathers. *Am J Orthopsychiatry, 69*(1), 30-38.

Stramrood, C. A. I., Doornobs, B., Wessel, I., van Geenen, M., Aarnoudse, J. G., van den Berg, P. P., Schultz, W. C. M. W., & van Pampus, M. G. (2013). Fathers with PTSD and depression in pregnancies complicated by preterm preeclampsia or PPROM. *Arch Gynecol Obstet 287*(4), 653-661. Doi: 10.1007/s00404-012-2611-0

Suto, M., Isogai, E., Mizutani, F., Kakee, N., Misago, C., & Takehara, K. (2016). Prevalence and factors associated with postpartum depression in fathers: a regional, longitudinal study in Japan. *Research in Nursing & Health, 39,* 253-262. Doi: 10.1002/nur.21728

Thorpe, K. J., Dragonas, T., & Golding, J. (1992). The effects of psychosocial factors on the mother's emotional well-being during early parenthood: A cross-cultural study of Britain and Greese. *Journal of Reproductive and Infant Psychology, 10*(4), 205-217.

Tohotoa, J., Maycock, B., Hauck, Y. L. Dhaliwal, S., Howat, P., Burns, S., & Binns, C. W. (2012). Can father inclusive practice reduce paternal postnatal anxiety? A repeated measures cohort study using the hospital anxiety and depression scale. *BMC Pregnancy & Childbirth, 12*(75). Doi: 10.1186/1471-2393-12-75

Top, E. D., Cetisli, N. E., Guclu, S., & Zengin, E. B. (2016). Paternal depression rates in prenatal and postpartum periods and affecting factors. *Archives of Psychiatric Nursing, 30,* 747-752. Doi: 10.1016/j.apnu.2016.07.005.

Vismara, L., Rollè, L., Agostini, F., Sechi, C., Fenaroll, V., Molgora, S., Neri, E., Prino, L. E., Odorisio, F., Trovato, A., Polizzi, C., Brustia, P., Lucarelli, L., Monti, F., Saita, E., & Tambelli, R. (2016). Perinatal parenting stress, anxiety, and depression outcomes in first-time mothers and fathers: A 3-to-6-months postpartum follow-up study. *Front Psychol, 7*(938). Doi: 10.3389/fpsyg.2016.00938.

Wang, S. Y., & Chen, C. H. (2006). Psychosocial health of Taiwanese postnatal husbands and wives. *J Psychosom Res, 60*(3), 303-307.

Wee, K. Y., Pier, C., Milgrom, J., Richardson, B., Fisher, J., & Skouteris, H. (2013). Fathers' mental health during the antenatal and postnatal periods: Knowledge, recommendations and interventions. *British Journal of Midwifery, 21*(5), 342-353.

World Health Organisation. (2017). *International Classification of Diseases for Mortality and Morbidity Statistics* (11 ed.).

Zhang, Y-P., Zhang, L-L., Wei, H-H., Zhang, Y., Zhang, C-L., & Porr, C. (2016). Postpartum depression and the psychosocial predicotrs in first-time fathers from northwestern China. *Midwifery, 35,* 47-52. Doi: 10.1016/j.midw.2016.01.005

Zilberman, M. L., Tavares, H., Blume, S. B., & el-Guebaly, N. (2003). Substance abuse disorders: Sex differences and psychiatric comorbidities. *Canadian Journal of Psychiatry, 48*(1), 5-1.

APPENDIX A. MMAT criteria & one-page template

Types of mixed methods study components or primary studies	Methodological quality criteria (see tutorial for definitions and examples)	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)?				
	Do the collected data allow address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components).				
	Further appraisal may be not feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)?				
	1.2. Is the process for analyzing qualitative data relevant to address the research question (objective)?				
	1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected?				
	1.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?				
2. Quantitative randomized controlled (trials)	2.1. Is there a clear description of the randomization (or an appropriate sequence generation)?				
	2.2. Is there a clear description of the allocation concealment (or blinding when applicable)?				
	2.3. Are there complete outcome data (80% or above)?				
	2.4. Is there low withdrawal/drop-out (below 20%)?				
3. Quantitative non-randomized	3.1. Are participants (organizations) recruited in a way that minimizes selection bias?				
	3.2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?				
	3.3. In the groups being compared (exposed vs. non-exposed; with intervention vs. without; cases vs. controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups?				
	3.4. Are there complete outcome data (80% or above), and, when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)?				
	4.2. Is the sample representative of the population understudy?				
	4.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)?				
	4.4. Is there an acceptable response rate (60% or above)?				
5. Mixed methods	5.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed methods question (or objective)?				
	5.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (objective)?				
	5.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design?				
	Criteria for the qualitative component (1.1 to 1.4), and appropriate criteria for the quantitative component (2.1 to 2.4, or 3.1 to 3.4, or 4.1 to 4.4), must be also applied.				

*These two items are not considered as double-barreled items since in mixed methods research, (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated.