

Paternal Prenatal, Perinatal and Postpartum Depression: A narrative review

Tiffany Field*

University of Miami/Miller School of Medicine, Fielding Graduate University, California, USA

*Corresponding author: Field T, University of Miami/Miller School of Medicine, Fielding Graduate University, California, USA, Tel: 13059755029; E-mail: tfield@med.miami.edu

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Abstract

This narrative review is based on a literature search on paternal perinatal depression studies published during the last 8 years. The research has primarily focused on paternal depression prevalence, effects and risk factors. Prevalence rates across the world have varied although, generally they have increased across pregnancy and the first 6 months postpartum followed by a decrease at one year postpartum. Paternal depression effects have ranged from continuing depression for the father, marital discord and negative parenting to sleep disturbances, irritability, hyperactivity and developmental delays in the infants of depressed fathers. Depression symptoms, attention and behavior problems have been reported for both their genetically related and adopted children and school performance problems for the adolescents. Risk factors for paternal depression include not wanting the pregnancy, marital conflict, comorbid maternal prenatal depression, history of depression and unemployment and stress hormones including higher cortisol levels, lower oxytocin levels and both lower and higher testosterone levels. Very few intervention and potential underlying mechanism studies have appeared in the literature, although assortative mating, emotional contagion and hormonal change models have been presented as possible mechanisms. Although the research on paternal depression has many methodological limitations including variability of measures and confounding variables, paternal depression is finally being examined alongside maternal depression as serious pregnancy and postpartum conditions.

Keywords: Paternal depression; Prenatal depression; Risk factors

1. Introduction

Paternal depression has received very little attention relative to the research focused on maternal depression. This has happened despite its significant prevalence and its negative effects on the fathers themselves, the family relationships and the development of the offspring. This lesser attention likely relates to the lower prevalence of paternal versus maternal depression. In addition, greater concern about maternal depression may relate to the intrauterine environment effects on the fetus and the primary caregiving typically by the mother during the postpartum period. The increasing prevalence of paternal depression and its negative effects on the fathers themselves, the mothers and their offspring highlight the importance of ongoing reviews for both researchers, clinicians and parents. The current narrative review involved a literature search on PubMed and PsycINFO for empirical studies, reviews and meta-analyses published over the last eight years (2010-2018) on

paternal prenatal/perinatal/postpartum depression. Exclusion criteria were case studies, pilot studies and foreign language publications. The literature of this time period has focused on four aspects of paternal perinatal depression, as the title suggests, including its prevalence and its effects, risk factors/predictors and interventions. This review is accordingly divided into sections focused on those topics. In addition, potential underlying mechanisms are explored and limitations/future directions are suggested.

2. Prevalence of Paternal Depression

The prevalence of paternal depression varies as a function of the location of the study, the year of the study and the measure of depression. Despite this variability, paternal perinatal depression would appear to increase across pregnancy and the first six months postpartum, just as it has for perinatal maternal depression. Several moderating risk factors have been noted in the different prevalence studies including a history of depression in the fathers and the comorbidity of maternal depression.

In a meta-analysis on paternal depression during pregnancy and the postpartum period, 41,480 participants were included in 74 studies that covered a 35 year period from 1980 to 2015 [1]. The meta-estimate was 8.4% for paternal depression from the first trimester to one-year postpartum. Surprisingly, the prevalence across the 74 studies did not relate to the fathers' depression history, paternal age or education and parity. These factors were included in moderator analyses along with the assessment measure, the timing of assessment and the publication year. Because this is a meta-estimate over 35 years, it does not reflect the increase in documented paternal perinatal depression. In a more recent study from Japan, the prevalence of perinatal postpartum depression was slightly greater as assessed from 20 weeks gestation through to two months postpartum [2].

Although very few researchers have conducted longitudinal assessments across the prenatal and postpartum period, those few studies combined suggest increasing prevalence across pregnancy and the first six months postpartum. For example, the prevalence in a Japanese study was 9.7% at 20 weeks gestation [2] while a greater prevalence of 13.3% was noted at 32 weeks gestation in a study using the same Edinburgh Depression Scale [3]. In this study, several factors were related to prenatal depression in the 622 men who were assessed including a family history of depression, low social support and low marital satisfaction as well as more stressful events and financial stressors during the previous six months.

Still later at birth and six weeks, the prevalence of depression had doubled by six weeks in a Nigerian study [4]. Although the incidence of maternal depression at six weeks was three times that of paternal depression, maternal and paternal depression was not significantly correlated at six weeks. The rate of depression among unemployed fathers was 10 times that of those employed. At three months postpartum, 20% of fathers scored above 12 on the Edinburgh Postnatal Depression Scale in a sample from Tehran [5]. Similarly, a rate of 17% at three months postpartum was reported in a Japanese study [6]. In a logistic regression analysis on this sample, only prenatal depression and a history of psychiatric treatment were related to the fathers' postpartum depression.

At six months, a higher rate of 26% was reported in a meta-analysis on 43 studies involving 28,004 participants [7]. A moderate correlation was noted between paternal and maternal depression in that meta-analysis ($r=.31$). A similarly high rate was noted for paternal depression from 4-8 months (21%) in a study from Finland [8]. Surprisingly, the rate for mothers was

similar instead of greater. By one year, the rates of paternal depression had decreased. For example, in a U.S. study only 7% of fathers were noted to be depressed at that time [9].

Thus, these studies taken together highlight the increasing prevalence of depression across pregnancy and the first six months postpartum with a lessening prevalence noted by one year postpartum. The studies are not comparable in many ways including their location, their year of publication, their sample size and the confounding factors that were considered. Nonetheless, they are suggestive of an increasing prevalence across pregnancy and the first six months, followed by a decrease during the subsequent months. These trends highlight the need for longitudinal assessments across pregnancy and the first year within the same sample.

Factors related to prevalence rates in addition to those already mentioned have included non-resident fathering, variability in paternal depression severity as reported by fathers versus mothers and proxy screening for paternal depression. In a study comparing resident with nonresident fathers, depressive symptoms were higher for nonresident fathers than for resident fathers, although resident fathers showed increasing depressive symptoms across the first five years in this 23-year longitudinal study of 10,623 fathers [10]. Surprisingly, in a study on reports of paternal perinatal depression by Japanese men versus women, the men reported more symptoms than their female partners [11]. The fathers may have manifested fewer symptoms for the mothers to notice and/or the mothers may have been too preoccupied with pregnancy and with later caregiving to notice the fathers’ symptoms. However, the authors attributed this to more accurate reporting by men versus women even though they had no independent ratings to check the validity of the fathers’ self-reports. In contrast, in an American study, the mothers’ assessments of the fathers’ depression on the Edinburgh Postnatal Depression Scale-Partner Version were found to be reliable and valid [12]. These authors concluded that the mothers provided a good proxy screening of paternal depression (TABLE 1).

TABLE 1. Prevalence of paternal prenatal, perinatal and postpartum depression (time period, prevalence and first author).

Time period	Prevalence	First author
First trimester to year 1	8.4	Cameron [1]
20 weeks gestation	9.7	Takehara [2]
32 weeks gestation	13.3	Da Costa [3]
3 months postpartum	20.0	Kamalifard [4]
3 months postpartum	17.0	Suto [6]
6 months postpartum	26,0	Paulson [7]
4-8 months postpartum	28,0	Luoma [8]
One year postpartum	7.0	Davis [9]

3. Paternal Depression Effects

As in maternal depression, paternal depression has many negative effects on the fathers themselves, their family relationships and their offspring. These effects range from continuing depression for the father, marital discord, negative parenting, and

developmental effects on infants, toddlers, preschoolers, grade school children and adolescents. This section on effects is accordingly divided by those topics (TABLE 2).

TABLE 2. Effects of paternal prenatal, perinatal and postpartum depression.

Effect	First author
Parents	
Postpartum depression & increasing maternal depression	Paulson, Koh [13,14]
Disturbed marital relationship	Ramchandari [15]
Negative marital & offspring relationship	Kouros [17]
Negative parenting	Takehara, Nath, Davis Wilson [2,18,9,19]
Infants	
Less breastfeeding	Goyal [20]
Less management infant sleep	Hall [21]
Greater irritability & hyperactivity	Gentile [22]
Difficult father-infant interactions	Barker, Selma [23]
Delayed development	Hoffman [27]
Preschoolers	
Less positive affect	Kryski [28]
Depression	Tichovolsky [29]
Behavior problems	Fletcher [30]
Attention problems	Van Batenburg-Eddes [31]
Grade school children	
Social and emotional well-being	Hancock, Ringoot [33]
Behavior and emotional problems	Gutierrez-Golve [34]
Cortisol reactivity	Mackrell, Essex [35,36]
Depressive symptoms	Liskola, Rice [37,39]
Adolescents	
Depressive symptoms	Mikkonen, Lewis, Pearson, Reeb [38,41-43]
Anxiety symptoms	Fjermesta, Leis [44,45]

3.1 Paternal prenatal depression leads to postpartum depression

In at least two recent studies, paternal prenatal depression has led to postpartum depression. In one study 86% of 80 fathers who were depressed at 28 weeks gestation experienced persistent depressive symptoms through six months postpartum [13]. Paternal prenatal depression also predicted increasing depression severity in the mothers across the first six months postpartum. In a larger sample of 622 expectant fathers from Hong Kong, paternal prenatal depression significantly predicted paternal postpartum depression [14]. This continuing depression during the postpartum period was associated with significant community care costs in a sample of 192 fathers from southern England. These costs, not surprisingly, related to emotional costs of disturbed marital and family relationships.

3.2 Disturbed marital and family relationships

Marital and family relationships have been negatively affected by paternal perinatal depression. In a controlled study on 153 fathers with and without a diagnosis of depressive disorder, depression during the first three months postpartum was associated with increased disharmony in the partner relationship based on both paternal and maternal report [15]. In a

longitudinal study across the first 18 months postpartum, both maternal and paternal depressive symptoms were noted to negatively affect co-parenting support and lead to conflict during mother–father–child interaction observations [16]. Both negative marital and family relationships have been noted by others. For example, in a study on 203 families, mothers and fathers completed daily diaries for two weeks on the emotional quality of their relationships with their spouse and with their child [17]. The authors' spillover hypothesis was supported by the positive relationships between mothers' and fathers' daily readings of marital quality and, in turn, their readings of parent-child relationship quality. Following time-lagged data analysis, both maternal and paternal depressive symptoms moderated the relationship between marital quality and the other parent's relationship quality with the child. This spillover effect of negative marital quality has led to negative parenting by depressed fathers.

3.3 Negative parenting

Negative parenting has been associated with paternal depression in a study from Japan, surveys from the UK, and in a large cohort study as well as a meta-analysis from the U.S. In the Japanese study, paternal depression as self-reported at 2 months post-birth was significantly correlated with a child maltreatment tendency also self-reported at 2 months [2]. In the British surveys, paternal postnatal depressive symptoms were associated with fathers' negative parenting [18]. In the large cohort study from the U.S., interview data from 1746 fathers of 1-year-old children suggested that the depressed fathers were more likely to report spanking their children (41% versus 13%) and they were also less likely to report reading to their children [9]. In the reputedly first quantitative synthesis of the empirical literature on paternal depression effects on fathers' parenting, a meta-analysis was conducted on 28 studies [19]. The effect sizes that were noted for the relationship between paternal depression and the fathers' parenting behavior were comparable to those that have been reported for maternal depression. The deleterious effect of paternal depression on parenting behavior was moderated by the child's and the father's age as well as the sample race/ethnicity, and the effects were comparable across self-report and observational studies. That these negative parenting behaviors were self-reported by depressed fathers was surprising. These fathers may have been reporting these to highlight their need for treatment. In at least the study on spanking, for example, 77% of depressed fathers reported that they had talked with their children's doctor in the previous year, suggesting that pediatricians may be primary contacts for perinatally depressed fathers [9].

3.4 Paternal depression effects on infants

Several paternal depression effects on infants have been noted. These include less breast-feeding, lower sleep quality, greater irritability, hyperactivity and developmental delays. These may in part be mediated by less playful, stimulating father-infant interactions.

In a breastfeeding study from India, high Edinburgh Depression Scale scores in fathers as well as mothers were associated with lower breast-feeding rates at one week post-birth [20]. Although parents' scores were concordant, surprisingly, fathers of girls had higher depression scores. In a parental sleep quality study from Canada, paternal depression at 6-8 months post-birth was related to the fathers' sleep quality but also to the fathers' attitudes toward infant sleep [21]. These included their doubt about managing their infants' sleep and about setting limits on their infants' sleep. Surprisingly, infant sleep was not measured in this study.

In a review of the literature on untreated paternal perinatal depression, 23 studies met inclusion criteria for peer-reviewed articles published in English over the years 1980 to 2016 [22]. Paternal depression was associated with several infant/toddler problems including irritability, hyperactivity, conduct problems and developmental delays. These studies, however, had a number of methodological limitations including small samples, the use of self-report rather than structured interview diagnoses of depression as well as inclusion bias. These problems could be mediated by difficult father-infant interactions [23].

Depressed father–infant interactions have been recently observed at 3-months post-birth in both face-to-face and floor play situations by the same research group. In one study on face-to-face interactions, depressed fathers' speech featured more negative and critical utterances as well as more speech focused on the fathers' experience and less on the infants' experience [24]. In another study on face-to-face play interactions by the same group of researchers, depressed fathers showed less active engagement including less playfulness and less touching [25]. Although these fathers had been diagnosed based on structured interviews and the data analysis was controlled for infant irritability, these were small samples (N=19 depressed, 19 non-depressed fathers), and they were limited to mostly white, well-educated fathers. In a larger sample study by the same group, observations were conducted both on face-to-face and floor play interactions [26]. During the floor play interactions, the depressed versus non-depressed fathers were notably more withdrawn and were less verbally and behaviorally stimulating. Surprisingly, these studies were focused primarily on the fathers' interaction behavior rather than both the fathers' and the infants' behavior. Although the data analysis was controlled for infant irritability, the reciprocity of their behaviors was not assessed.

Just as depressed mothers' interaction behaviors have been implicated in the maternal depression effects literature, the fathers' interaction behaviors have been implicated as a mediator for later infancy and childhood problems rather than treating the depressed father and infant as a dyad with reciprocal influences. Data on the infants have been strikingly absent in these studies on perinatally depressed fathers. In addition, the infants may have developmental delays that relate to fetal development and/or genetic factors. In a review of the literature, for example, infants of perinatally depressed fathers have been noted to have delayed neurosynaptic development, regulatory development and developmental milestones that may or may not relate to paternal perinatal depression [27].

3.5 Paternal depression effects on preschoolers

Preschoolers have been notably affected by paternal perinatal depression. They have shown less positive affect and more negative affect, depression symptoms, attention and behavior problems. In a study on 968 three-year-olds, paternal depression history was associated with less positive affect and more negative affect in the preschoolers [28]. In this study on parent-child interactions, the direction of effects was not clear given that both the observation of preschoolers' affect and paternal depression were assessed at age 3 with no earlier measures. However, a longitudinal study of 153 preschool children over a three-year period suggested that paternal depression at one time point predicted preschoolers' depression at the next time point [29]. Child depression did not predict later paternal depression despite this sample being exclusively comprised of children with behavior problems which might have been expected to contribute to ongoing paternal depression.

Paternal depression as measured at one year has also been a significant predictor of behavior problems at 4-5 years based on the Strengths and Difficulties Questionnaire in a sample of 2620 preschool children in Australia [30]. This effect was significant even after controlling for both early maternal depression and later paternal depression. However, paternal depression during the three intervening years which would be expected to affect the children's preschool behavior was not assessed in this study.

Attention problems have also been related to paternal depression in a sample of 3442 preschoolers [31]. In this study, attention problems were assessed by the Child Behavior Checklist at age 3 and the Strengths and Difficulties Questionnaire at age 4. There was no statistical evidence that prenatal paternal depression had a different effect than maternal depression on attention problems.

These relationships between paternal depression and preschool outcomes may be mediated by other variables such as marital conflict. For example, in a study that assessed paternal depression during the second trimester and at eight months postpartum (the Avon Longitudinal Study on Parents and Children; N=14,541), the preschool child outcomes were mediated by marital conflict measured prenatally and postnatally [32]. Child neglect may be another mediating variable. In a study on 1089 families, paternal depression when a child was three years old was a mediator of the child being neglected at age 5 even after controlling for maternal depression and economic hardship.

3.6 Paternal depression effects on grade school children

Paternal perinatal depression has been noted to negatively affect grade school children's social and emotional well-being and to lead to depression and psychiatric morbidity. In addition, this age children have been noted to have hyper and hypo cortisol reactivity. Some of these effects have been reportedly mediated by marital conflict and dual exposure to both maternal and paternal depression. And, paternal depression has affected both genetically related and unrelated offspring.

Social and emotional well-being have been negatively affected by paternal depression in at least two different samples of Australian children age 5 to 6 years (N=4253) and 8 to 9 years (N=4196). Children's emotional and behavioral problems appeared to be equally associated with both maternal and paternal depression when child self-report was used [33]. However, when parents reported on the child's depression, the severity was more significantly related to the reporting parent's depression. These results are only suggestive as they were confounded by the parents reporting the child's depression at 3 years and the children reporting their own depression on a different measure at age 6.

Paternal depression effects on children are typically mediated by maternal depression as well as couple conflict. For example, in the Avon Longitudinal Study on Parents and Children, path analysis indicated that maternal depression and couple conflict mediated two thirds of the relationships between paternal depression and children's behavior and emotional problems at both 3.5 and seven years [34]. Surprisingly, there were no moderating effects.

Cortisol reactivity has also been assessed in children of depressed fathers. For example, in a longitudinal study, paternal depression as measured when children were seven years of age was predictive of cortisol stress reactivity when the children were nine years of age [35]. Similarly, in a prospective study on 357 children, paternal depression as assessed during infancy

and the preschool years was predictive of both hyper and hypo arousal of cortisol and mental health symptoms when the children were 9 to 15 years of age based on a hierarchical linear regression [36].

Paternal depression effects on adopted children have exemplified the non-genetic environmental effects of paternal postpartum depression. For example, depressive symptoms as measured by the Children's Depression Inventory have been greater in a study on Finnish adopted children of depressed fathers including negative mood and interpersonal problems [37]. Paternal depression effects have been noted in both genetically related and unrelated offspring. In one study, paternal depression effects were assessed in children born through assisted conception (a sample of 865 children related to both parents, the mother only, the father only or neither parent) [38]. In this study, significant correlations were noted for unrelated father-child pairs and related father-child pairs. However, a path analysis by the same group on the same sample yielded paternal positivity as a mediator for the link between paternal depression and child depression but only in genetically related father-child pairs [39].

3.7 Paternal depression effects on adolescents

Paternal depression has contributed to depression symptoms and anxiety disorder in adolescents. Not surprisingly, then, adolescents' school performance has been negatively affected [40]. In this very large sample of 1,124,162 Swedish adolescents, both paternal and maternal depression assessed before birth, after birth and throughout the school years were associated with worse school performance.

The incidence of depressive symptoms in adolescents 15 to 20 years of age has been assessed in a Finnish sample [41]. Dual exposure to both maternal and paternal depressive symptoms had more negative effects than single exposure alone, and adolescents who had been exposed to recurrent depression from 0 to 5 and from 9 to 14 had a greater risk for depressive symptoms than those who been exposed at only one time period [41]. Surprisingly, in this study, maternal depression had negative effects on both boys and girls, but paternal depression had less effect on girls. These results are tentative given that depressive symptoms were not measured directly but from antidepressant purchases and treatment records. However, depressive symptoms in adolescents have been associated with paternal depression in at least two other studies including the Millennium Cohort study (N=7768) and the Growing Up in Ireland study (N=6070) (Lewis et al, 2017). Further, associations between paternal depression and adolescent depression have been noted in the Avon Longitudinal Study of Parents and Children (N=4500) [42]. Although postnatal paternal depression had similar effects as maternal postpartum depression on these 18-year-old adolescents, prenatal paternal depression was not associated with adolescent depression. When paternal depressive symptoms were measured in early adolescence, they predicted depressive and anxiety symptoms as late as age 21 (N=395) [43]. Surprisingly, maternal depression and child gender did not moderate these associations in this sample.

Anxiety symptoms have also occurred in adolescents of depressed fathers [44]. Interestingly, regression analyses revealed that paternal depression symptoms but not anxiety symptoms were related to higher anxiety in the adolescents as rated by the parents. However, paternal depression symptoms were also associated with the parents rating the adolescents' anxiety as greater than the adolescents rated their own anxiety. These complex findings are difficult to interpret. When severity of paternal depression was assessed in another study, major and minor paternal depression was associated with anxiety disorders in the young adults of depressed fathers [45]. However, the risk for lifetime anxiety disorder did not vary as a function of the

severity of depression in the father. In a systematic review of 21 studies on the effects of paternal depression on children and adolescents, paternal depression during the prenatal and postnatal stages as well as during adolescence was associated with several mediators [46]. These included paternal negative expressiveness and hostility as well as marital conflict.

4. Predictors/Risk Factors for Paternal Depression

Several predictors/risk factors have been identified for paternal perinatal depression. These include prenatal variables of not wanting the pregnancy, marital conflict and comorbid maternal prenatal depression. Personal risk factors include history of depression and unemployment. Additional predictors include perceived stress as well as stress hormones including higher cortisol levels, lower oxytocin levels and both lower and higher testosterone levels. Offspring factors that have contributed to paternal perinatal depression include a previous perinatal loss, having a very low birth weight infant and having an infant hospitalized in the neonatal intensive care unit (TABLE 3).

TABLE 3. Predictors of paternal prenatal, perinatal and postpartum depression.

Predictors	First Authors
Unwanted/unintended pregnancy	Top, Nishimura [47,48]
Marital conflict	Nath [49]
Comorbid maternal depression	Edward [50]
Paternal stress and health problems	Underwood [51]
High cortisol levels	Sunstrum [52]
High and low testosterone levels	Saxbe [53]
Perinatal loss	Demontigny [54]
Low birthweight and prematurity	Barkmann, Gonulal [55,56]

Fathers who suggested that they did not want the pregnancy have had higher depression scores (on the EPDS) according to a recent study that involved interviews between the 37th and 40th weeks of pregnancy and again at 4 to 6 weeks postpartum [47]. The fathers with higher depression scores were also experiencing more marital conflict. Although these findings are not surprising, this may be a self-selected sample inasmuch as the couples were only applying to the gynecology clinic very close to their delivery dates. In addition, the paternal and maternal scores on the EPDS were, surprisingly, not correlated. In a similar study from Japan, unintended pregnancy was associated with paternal depression, again based on scores on the EPDS [48]. A logistic regression analysis suggested that employment status and history of psychiatric treatment were also associated with paternal depression. Once again, the maternal and paternal depression scores were not correlated. In a study from the UK, similar risk factors were consistently noted across the first seven years of the child’s life including marital conflict, history of unemployment and maternal depression [49]. Not surprisingly, an integrative review of 63 articles suggested that paternal postpartum depression was associated with comorbid maternal depression during pregnancy and after delivery as well as a personal history of depression [50].

Several physical risk factors have been reported for paternal depression. For example, in a study on 3523 New Zealand men, interviews during the partner’s pregnancy and nine months post- delivery, the men completed the EPDS and a health questionnaire [51]. During the pre-partum period, the men who felt stressed and had health problems had more depression symptoms. Post-pregnancy depression symptoms were associated with adverse relationships. The elevated stress factor may

explain the higher cortisol levels noted in depressed fathers in a review of the literature on paternal depression [52]. In this review, references were also made to low levels of testosterone and oxytocin. Both high and low levels of testosterone have been reported in a study on 149 couples [53]. This curvilinear relationship emerged at nine months. Those fathers with high and low testosterone had more depression symptoms at 15 months. Curiously, the mothers whose partners had higher testosterone levels reported more depressive symptoms. Higher paternal testosterone and depressive symptoms at nine months also predicted greater parenting stress for fathers at 15 months and more mother-reported partner aggression. Without a regression or structural equations analysis, the relative importance of these variables cannot be determined. The direction of effects also cannot be determined as these are as likely to be effects of depression as they are risk factors for paternal depression.

Paternal depression has also been associated with previous pregnancy loss as well as high-risk neonatal outcomes including very low birth weight and hospitalization in the neonatal intensive care unit (NICU). In a small sample correlation study, paternal depression was associated with perinatal loss in a previous pregnancy [54]. In a latent growth curve model study, very low infant birth weight was a predictor of paternal depression over the course of five years [55]. In a study on the parents of NICU preterm infants, paternal depression was unusually high at both the second and the sixth week postpartum [56]. In this study, the severity of the infants' condition was significantly correlated with the paternal depression scores. Once again, the directionality cannot be determined here as prenatal paternal and/or maternal depression could have predicted pregnancy loss, very low birth weight and hospitalization in the NICU.

5. Interventions

Given the negative effects of paternal depression on the offspring, it is surprising that only a few intervention studies have appeared in the recent literature. Of those few studies, some interventions for paternal depression have happened naturally such as social support and maternal parenting which have been viewed as buffers for paternal depression. Others were conducted by design including group lifestyle-based training and cognitive behavior therapy. Unfortunately, the literature suggests that if the child's mother is depressed and treated, the child's symptoms decrease, but if the child's father is depressed and is treated, the child's symptoms do not change (TABLE 4).

TABLE 4. **Interventions for paternal prenatal, perinatal and postpartum depression.**

Interventions	First author
Maternal parenting	Kujawa [58]
Group lifestyle-based training	Charandabi [59]
Cognitive Behavioral Therapy	O'Brien [60]

In a Delphi consensus study, both professionals and consumers were asked questions about the types of interventions that might be effective for depressed fathers [57]. The consensus was that communication and both practical and emotional support were the most effective natural interventions. In another natural intervention study, parenting was assessed at preschool age and the children were given assessments of event related potentials at age 9 (58). Maternal parenting was a notable buffer for paternal depression effects on the offspring in this study.

In a designed intervention study, group lifestyle-based training was provided twice weekly for sixty to ninety-minute sessions [59]. The results suggested that at six weeks postpartum both paternal depression and anxiety were decreased. In a cognitive behavior therapy study, group work and blended delivery programs including e-support were effective in reducing paternal perinatal depression [60].

6. Potential Underlying Mechanisms/ Theoretical Models

Paternal depression researchers have primarily focused on its prevalence, effects and risk factors with very little consideration of potential underlying mechanisms/theoretical models. Although many risk factors have been explored, these were not framed as potential underlying mechanisms or theoretical models for paternal depression. Based on the recent risk factor literature, some mechanisms/theoretical models could be proposed. These would include a self-selection/matching hypothesis or assortative mating model, as well as emotional contagion and hormonal change models (TABLE 5).

TABLE 5. Potential underlying mechanisms/theoretical models for paternal prenatal, perinatal and postpartum depression.

Model	First author
Matching hypothesis	Korsor [61]
Assortative mating	Guo [62]
Emotional contagion/mirror neurons	Hatfield, Van derGaad [63,64]
Hormonal changes/sympathetic pregnancy	Brennan, Storey [65]

In a self-selection/matching hypothesis/assortative mating model, one could argue that males with perinatal depression may have a longer history of depression, as many have claimed in this literature. And, via self-selection/ matching they became attracted to depressed females which could explain the high concordance noted between maternal and paternal depression. The matching hypothesis introduced by Elaine Hatfield suggests that people are attracted to and form relationships with individuals who resemble them on a variety of attributes and personality traits [61]. In the assortative mating model, selection of individuals occurs for those with similar phenotypes more frequently than would be expected by chance and that could be social assortative mating based on social factors [62].

Instead, expectant fathers may not be depressed but begin to experience depression as they are exposed to depressed expecting mothers via emotional contagion. In Emotional Contagion Theory one person’s emotions and behaviors can trigger similar emotions and behaviors in others [63]. This happens through automatic mimicry and synchronized postures and movements. When individuals are mirroring others’ behaviors (through mirror neurons) they come to feel the same emotions. This may be a primitive, automatic and unconscious experience [64]. Expectant fathers can also experience hormonal changes including decreased testosterone and estradiol and increased cortisol [65]. These hormonal changes simulate those of the expectant mother and have been called the Couvade Syndrome or sympathetic pregnancy as the partner experiences the same symptoms and behaviors as the expectant mother.

Potentially, all of these models may apply to paternal depression. Although very large epidemiological studies have established prevalence, effects and risk factors for paternal perinatal depression, it may be necessary to also explore potential underlying mechanisms/theoretical models to further understand how paternal depression develops.

7. Limitations and Future Directions

Several limitations have been noted in the recent literature on paternal perinatal depression. They start with the literature being focused on the prevalence, effects and risks/predictors studies with very few intervention studies and literally no studies focusing on underlying mechanisms/theoretical orientations. No meta-analyses have appeared in the literature, probably because of the extreme variability on the different measures used, the different assessment periods and even the different scales used for mothers and fathers in the same studies. Variability has been related to the assessment period, for example, with low depression being noted during the first trimester and an increase during the third trimester followed by an increase across the first six months postpartum but then decreasing at one year.

Further, the almost exclusive use of self-report has been a problem. And the parents' scores have been inflated compared to the scores given by their offspring in at least two studies on children and adolescents, suggesting the need for multiple assessors (both children and their parents). As compared to self-report measures, physiological and biochemical variables have rarely been used in the paternal depression literature which is surprising given that models for those measures have been given in the maternal depression literature. For example, vagal tone, neurotransmitter and stress hormone measures have been documented for both depressed mothers and their offspring but do not appear yet in the literature on depressed fathers and their offspring.

Comparisons of the mothers' and fathers' depression have often come from separate samples and often the partner's depression has not been entered as a confounding variable in the paternal depression effects literature. Maternal and paternal depression is often concordant, although they are not very often documented in the same study. In addition to the confounding parent variables, several infant and child variables have confounded the results. For example, reciprocal effects have been noted for parent and infant sleep and for their interaction behaviors. Other confounds such as marital problems and infant temperament has not been entered as covariates in most studies.

Paradoxically, some risk variables have been curvilinear which raise complex questions for intervention. For example, the relationship between paternal depression and testosterone has been complex with high testosterone levels in the fathers being better for the fathers but being worse for the mothers and vice versa. Mediator/moderator variables are clearly apparent in this literature but mediator/moderator analyses and structural equations analysis have rarely been used. Even regression analysis has been rarely conducted to assess the relative variance explained by the predictor variables.

In some studies, paternal perinatal depression effects have been similar to maternal perinatal depression effects and it hasn't been clear why this has happened. Fathers may be the primary caregivers in some cases which could contribute to their paternal depression, but this factor has not been considered within family studies. Environmental effects may be greater than genetic effects, although paternal depression effects have been noted for both genetically and non-genetically related fathers.

If the fathers were historically depressed they could have contributed to the depression in their offspring not only genetically but also via sperm defects, as has been demonstrated in monkey studies.

One of the enduring questions is directionality and causality. Paternal depression effects on the offspring could have resulted from prenatal paternal depression. Or, paternal depression, as already noted, could have resulted from assortative mating or emotional contagion. For example, it is not clear whether very low birth weight, premature, NICU and previous perinatal losses resulted from prenatal depression or those events caused postpartum depression in the fathers.

Clearly, more multivariate studies need to be conducted using mediator/moderator or structural equations analysis following on theoretical models that inform the research. The research on paternal depression is relatively new but could benefit from the theoretical and statistical models that have informed the maternal depression research. The prevalence, effects and risk factors research has suggested strong parallels and similarities between the maternal and paternal depression research. However, even the maternal depression research has not provided compelling models for conducting research and interventions. The increasing prevalence of paternal perinatal depression and its serious effects on the offspring highlight the need for further research.

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