



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

ARCHIVIO ISTITUZIONALE
DELLA RICERCA

Alma Mater Studiorum Università di Bologna Archivio istituzionale della ricerca

Reciprocal Influence of Depressive Symptoms Between Mothers and Fathers During the First Postpartum Year:
A Comparison Among Full-Term, Very Low, and Extremely Low Birth Weight Infants

This is the submitted version (pre peer-review, preprint) of the following publication:

Published Version:

Reciprocal Influence of Depressive Symptoms Between Mothers and Fathers During the First Postpartum Year: A Comparison Among Full-Term, Very Low, and Extremely Low Birth Weight Infants / Neri E.; Giovagnoli S.; Genova F.; Benassi M.; Stella M.; Agostini F.. - In: FRONTIERS IN PSYCHIATRY. - ISSN 1664-0640. - ELETTRONICO. - 11:(2020), pp. 578264.1-578264.11. [10.3389/fpsyt.2020.578264]

Availability:

This version is available at: <https://hdl.handle.net/11585/788800> since: 2022-11-24

Published:

DOI: <http://doi.org/10.3389/fpsyt.2020.578264>

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (<https://cris.unibo.it/>).
When citing, please refer to the published version.

(Article begins on next page)

1 **Reciprocal influence of depressive symptoms between mothers and**
2 **fathers during the first postpartum year: a comparison among full-**
3 **term, very low and extremely low birth weight infants**

4 Neri, E.^{1*}, Giovagnoli, S.¹, Genova, F.¹, Benassi, M.¹, Stella, M.², Agostini, F.¹

5 ¹Department of Psychology, University of Bologna (Italy)

6 ²Paediatric and Neonatal Intensive Care Unit, Maurizio Bufalini Hospital, Cesena (Italy)

7 * **Correspondence:**

8 Corresponding Author

9 erica.neri4@unibo.it

10 **Keywords: Perinatal Depression, Mothers/Fathers, Extremely Low Birth Weight, Very Low**
11 **Birth Weight, Actor-Partner Interdependence Model (APIM).**

12 **Abstract**

13 **Background:** Perinatal depression (PND) in mothers and fathers of very low and extremely low birth
14 weight (VLBW and ELBW) infants has not been studied extensively. In particular, no studies
15 investigated the reciprocal influence of depressive symptoms during the first 12 months postpartum.
16 This study aimed at exploring the impact of the severity of prematurity on maternal and paternal
17 PND during the first postpartum year; specifically, we used an Actor–Partner Interdependence Model
18 (APIM) to test the interdependence of both partners on depressive symptoms.

19 **Methods:** 177 mothers and 177 fathers were recruited, divided in 38 couples with ELBW infants, 56
20 with VLBW and 83 of Full-Term (FT) infants. PND was evaluated by the Edinburgh Postnatal
21 Depression Scale (EPDS) at 3, 9 and 12 months postpartum (corrected age for preterm infants).

22 **Results:** Maternal depressive symptoms at 3 months were positively related to those at 9 and 12
23 months, in the 3 groups. Conversely, paternal depressive symptoms assessed at 3 months were
24 positively related to those measured at: 9 months for ELBW group, 12 months for VLBW group, 9
25 and at 12 months for FT condition. Furthermore, a significantly positive partner effect was observed,
26 regarding the influence of 3 month-maternal depressive symptoms on paternal depressive symptoms
27 at 9 months, but only in the case of VLBW group.

28 **Conclusion:** Prematurity represents a very specific scenario in the transition to parenthood, leading
29 to specific reactions in mothers and fathers, especially in high-risk condition. Results should be
30 deepened given the relevance of their clinical implications.
31

32 1 Introduction

33 Perinatal depression (PND) is a serious mental disorder, characterized by onset during pregnancy
34 and/or within a year after childbirth (Patel et al., 2012) and symptoms like mood lability, insomnia,
35 disorganized behaviour, irritability and agitation (Monzon et al., 2014). The risk of PND is widely
36 recognized in mothers, with an overall prevalence of about 17% (Gavin et al., 2005; Hahn-Holbrook
37 et al., 2018; Shorey et al., 2018), but recent literature observed a relevant prevalence also in fathers,
38 which estimated rate is about 10% (Paulson and Bazemore, 2010; Cameron et al., 2016).

39 The prevalence of PND could be particularly significant in high-risk contexts, such as in the situation
40 of a preterm birth.

41 Prematurity, the condition of all births occurring before the 37th week of pregnancy (World Health
42 Organization, 2012), represents an unexpected and stressful event for the parents, who might
43 experience feelings of guilt, grief and recurrent worries about their baby's survival and health (Miles
44 et al., 2007; Mehler et al., 2011; Shah et al., 2011; Gray et al., 2012; Lasiuk et al., 2013; Helle et al.,
45 2015; Pace et al., 2016; Pisoni et al., 2019). The stress experienced can reach such a high intensity to
46 represent a traumatic experience, in some cases satisfying the criteria to diagnose a post-traumatic
47 stress disorder (Pierrehumbert et al., 2003; Kersting et al., 2004; O'Donovan and Nixon, 2019).

48 Both preterm infants' mothers and fathers may also experience high levels of depressive symptoms
49 that could persist (Miles et al., 2007; Vigod et al., 2010; Pace et al., 2016). Indeed, recent studies
50 found a range of prevalence of PND in preterm babies' mothers of 15-27% in the first 3 months
51 (Agostini et al., 2014; Helle et al., 2015; Neri et al., 2015; Pisoni et al., 2019), and of 14-21% at 9
52 and 12 postpartum months (Miles et al., 2007; Cheng et al., 2016; Quist et al., 2019), confirming that
53 maternal PND after a preterm birth may be significantly more frequent compared to mothers of full-
54 term (FT) infants (Vigod et al., 2010; Neri et al., 2015). Recently, an increased interest has been paid
55 also to PND in preterm babies' fathers: nevertheless, to our knowledge, studies are sparse and
56 investigated depressive symptomatology only at 3 months postpartum, reporting 0-6% as a range of
57 prevalence (Mehler et al., 2014; Helle et al., 2015).

58 The risk of PND may be intensified when prematurity is more severe (Vigod et al., 2010; Barkmann
59 et al., 2018). Nevertheless, studies usually focus on Low Birth Weight-LBW and Very Low Birth
60 Weight-VLBW babies (birth weight <2500 and 1500 grams, respectively) (Treyvaud, 2014; Helle et
61 al., 2015), neglecting the investigation of a more severe preterm birth condition represented by the
62 Extremely Low Birth Weight-ELBW (<1000 grams). This population may increase the occurrence
63 for maternal PND, as shown by previous studies (Agostini et al., 2014; Neri et al., 2015), where a
64 greater risk for PND emerged in ELBW mothers rather than in VLBW ones. Conversely, to our
65 knowledge, no studies have explored paternal PND in the case of ELBW infants.

66 Another relevant issue in the evaluation of PND in parents of preterm infants regards the possible
67 association between maternal and paternal depression. To our knowledge, studies often have focused
68 separately on mothers or fathers, while the reciprocal influence between partners on depressive
69 symptoms has been neglected. Conversely, the association between maternal and paternal PND has
70 been deeply investigated in parents of healthy full-term infants, but giving somewhat inconsistent
71 findings. Indeed, while many researchers found an association between maternal and paternal PND
72 (Ramchandani et al., 2005; Anding et al., 2016; Narayanan and Naerde, 2016; Vismara et al., 2016;
73 Canario and Figueredo, 2017; Kiviruusu et al., 2020), others observed a predictive role of only
74 maternal (Kerstis et al., 2013; Nishimura et al., 2015; Xu et al., 2016; Da Costa et al., 2019;

Reciprocal influence of PND in preterm mothers and fathers

75 Fredriksen et al., 2019) or paternal PND on partner's symptomatology (Matthey et al., 2000; Paulson
76 et al., 2016); again, other studies did not find any significant associations (Wynter et al., 2013;
77 Ayinde and Lasebikan, 2017; Ierardi et al., 2019). One reason for the inconsistency of these results
78 may be represented by the heterogeneity of the methodology. In particular, many different statistical
79 analyses have been used in the studies; quite often the statistical methods do not seem appropriate for
80 assessing the interdependence, and the direction of the relations found between members of dyads
81 (i.e. correlational analysis, MANOVA or Linear Regression). In this context, a promising statistical
82 approach could be represented by the Actor-Partner Interdependence Model (APIM; Cook & Kenny,
83 2005; Kenny et al., 2006). Using Structural Equation Modelling, APIM treats data from both dyad
84 members as nested scores within the same group (i.e., the parental couple), providing both the extent
85 to which one partner's independent variable score influences his/her dependent variables score (actor
86 effect) as well as the other partner's dependent variables score (partner effect). Although different
87 methodological and data-analytic approaches are useful in the study of dyads (i.e. Multiple
88 Regression, Multilevel Modelling), Structural Equation Modelling is one of the most widely used
89 data-analytic techniques in social and behavioural sciences. To our knowledge, no study assessed the
90 reciprocal influence of perinatal depressive symptoms between mothers and fathers using these
91 statistical models.

92 Another methodological issue regards the research design. Indeed, many studies on PND usually
93 have a cross-sectional design, assessing mothers and fathers in one step: to our knowledge, only few
94 studies investigated the evolution or the trajectories of maternal and paternal PND until 6 or 12
95 months postpartum (Escriba-Aguir and Artazcos, 2011; Paulson et al., 2016; Ayinde and Lasebikan,
96 2017; Da Costa et al., 2019; Fredriksen et al., 2019; Narayanan and Naerde, 2019; Volling et al.,
97 2019). This lack is particularly evident in literature on preterm parents, where only two studies
98 investigated parental PND longitudinally (Meheler et al., 2014; Pace et al., 2016).

99 Given that the perinatal period ranges from conception to the end of the first postnatal year, reflecting
100 the interval for the arrival of the baby and parental adjustment, the parental affective state should be
101 assessed in a longitudinal perspective.

102 For the above-mentioned reasons, there is a need of developing more research comparing maternal
103 and paternal PND, assessing both the influence of severity of prematurity and longitudinal effects.

104 Therefore, this study aimed at investigating the impact of severity of preterm birth on maternal and
105 paternal depressive symptoms at 3, 9, and 12 months of infant's age (corrected for preterm infants).
106 We hypothesized to find more intense symptoms of PND in the case of a more severe premature birth
107 (ELBW), compared to VLBW and FT conditions, especially in mothers (than fathers) and in the first
108 months postpartum. Also, we aimed at exploring whether the symptoms of PND of each partner at 3
109 months were associated to own and partner's symptoms at 9 and 12 months; specifically, we aimed
110 to measure interdependence within ELBW, VLBW and FT mothers and fathers applying an APIM
111 model.

112 We chose to observe parental PND at the specific time points of 3 and 9 months, considered two
113 milestones for infant development and, as consequence, important moments for parental adjustment;
114 furthermore, we added the assessment of parental PND at 12 months, in order to evaluate parental
115 PND through all the perinatal period.

116

117 **2 Methods**

118 2.1 Participants and procedure

119 The study participants were 354 parents (177 couples). Eighty-three couples were parents of full-term
120 infants, with a birth weight >2500 g and gestational age >36 weeks (FT group); the remaining 94
121 were parents of preterm infants. According to infant birth weight, they were differentiated in 56
122 couples with VLBW infants (weight between 1000 and 1500 g) and 38 couples with ELBW infants
123 (weight <1000 g).

124 ELBW and VLBW groups were recruited at Neonatal Intensive Care Unit (NICU) of Bufalini
125 Hospital (Cesena, Italy), while FT group was recruited at the antenatal classes held at Health Services
126 in the same town. Exclusion criteria were: previous or present psychiatric illness, lack of fluency in
127 Italian, severe neonatal pathologies.

128 All the assessments took place in Cesena at "Anna Martini" Laboratory (Department of Psychology,
129 University of Bologna) at 3, 9 and 12 months postpartum (T1, T2 and T3, respectively) (corrected
130 age for preterm infants). After providing the written informed consent, all parents fulfilled an *ad hoc*
131 questionnaire (regarding socio-demographic and infant variables) and a self-report questionnaire for
132 the assessment of depressive symptoms. The study was approved by the Ethical Committee of the
133 Department of Psychology (University of Bologna).

134

135 2.2 Measures

136 The Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) is the most widely used
137 instrument for the assessment of perinatal depressive symptomatology. It is a self-report
138 questionnaire, composed of 10 items, exploring the presence of depressive symptoms during the
139 previous 7 days. The EPDS was developed for use by postnatal women (Cox et al., 1987) and has
140 been implemented in international research for the detection of perinatal depressive symptoms (i.e.,
141 Evans et al., 2001; Bowen et al., 2012). Up to now, the EPDS has been translated into more than 60
142 languages (Cox, 2019). The questionnaire has been subsequently validated for the detection of
143 perinatal depression in men (i.e., Matthey et al., 2001; Ramchandani et al., 2005; Escriba-Aguir and
144 Artazcoz, 2011).

145 As recently underlined by the main author (Cox, 2019), the EPDS deliberately does not assess a
146 number of common depressive symptoms that are also common features of typical perinatal
147 adjustment; this increases the possibility of detecting individuals who truly exhibit a depressive state
148 across the perinatal period. The EPDS also includes some indicators of anxiety and omits somatic
149 symptoms of typical depression. For this reason, studies of the factor structure have identified at least
150 two factors, one represented by a “depressive core” and the other focused on “anxiety” (Matthey,
151 2008; Matthey et al., 2013).

152 All the items are scored from 0 to 3, providing a total score ranging from 0 to 30, allowing for
153 derivation of both continuous scores (a high score indicates the probable presence of depressive
154 symptoms) and/or dichotomous scores (referring to a cut-off value which enables identification of
155 individuals with depressive symptoms of clinical relevance). In this latter case, for the Italian version
156 of EPDS, Italian validation studies suggested an optimal cut-off of 9/10 for women (Benvenuti et al.,
157 1999) and 12/13 for men (Loscalzo et al., 2015). The version for men has been more recognized as a
158 reliable and valid measure for the detection of distress, rather than proper depression, supporting the
159 findings by previous international studies (Matthey et al., 2001; Massoudi et al., 2013). This state of

Reciprocal influence of PND in preterm mothers and fathers

160 distress would be mainly characterized by unhappiness and anxiety and less by the most common
161 depressive symptomatology.

162

163 2.3 Data Analysis

164 Firstly, according to our first aim, Repeated Measures ANOVA was run to compare the level parental
165 PND according to the birth weight (ELBW, VLBW vs FT), parental gender (mothers vs fathers), and
166 time of assessment (3, 9, and 12 months of age). Moreover, the frequencies of depressed parents
167 among ELBW, VLBW and FT groups at the 3 times of assessment were investigated by Chi-square
168 analysis.

169 Secondly, preliminary analyses were carried out to justify the need for further investigation of the
170 relation between maternal and paternal depressive symptomatology via dyadic data analysis. One
171 fundamental principle with dyadic data is that members of a dyad cannot be considered completely
172 independent one from the other because they share and/or develop similarities in some of their
173 psychological attributes (Kenny et al., 2006). Specifically, correlation analyses between the
174 depression levels in mothers and fathers at T1, T2 and T3 were conducted.

175 To account for the interdependence of dyadic data, we tested two Actor-Partner Interdependence
176 models (APIM). APIM analyses were carried out for exploring, separately for each infant birth
177 weight group, the relation between one parent's levels of depressive symptoms at T1 on his/her own
178 levels of depressive symptoms at T2 and at T3 respectively (that is, actor effect), as well as on the
179 other partner's levels of depressive symptoms at T2 and at T3 respectively (that is, partner effect).

180 APIMs were estimated using path analysis (Maximum Likelihood estimation method) that is a
181 special case of Structural Equation Models without latent variables. All the analyses were performed
182 using Lavaan software (Rosseel, 2012; Stas et al., 2018). In order to test empirically the
183 distinguishability of dyad members by parental gender, an omnibus test of distinguishability has been
184 done for both T1->T2 model and T1->T3 model. The coefficients have been tested using Z tests. The
185 APIM test consists of a two-step approach. In the first step, the saturated APIM model looks for
186 significant actor and partner effects. In the second step, the saturated APIM with K parameters (ratio
187 of the partner to actor effect) is computed separately for each parent of the dyad to provide
188 information about the type of dyadic pattern that characterize the effects reported in the model
189 (Kenny and Ledermann, 2010). Step 2 was not performed if the absolute standardized values of the
190 actor effects were less than 0.10; indeed, weak actor effects combined with strong partner effects
191 would suggest the presence of a partner-only pattern (Fitzpatrick et al., 2016). The regular
192 bootstrapping method was used to calculate confidence intervals of k values. Cases with missing data
193 were handled using Full Information Maximum Likelihood estimation (Enders and Bandalos, 2001).
194 Because the standard APIM is a saturated model, it is just-identified and therefore has only one
195 unique solution. A just-identified model has trivially perfect fit; therefore, information about model
196 fit (e.g., RMSEA, CFI, etc.) is uninformative for the standard APIM and is not reported (Kenny,
197 2012). Instead, model evaluation is based on the magnitude and significance of the path estimates.

198

199 3 Results

200 3.1 Descriptive Characteristics

Reciprocal influence of PND in preterm mothers and fathers

201 Descriptive analyses showed an overall homogeneity among the 3 birth weight groups, except for
202 parity and maternal education variables (Table 1): VLBW mothers were primiparous in a lower
203 percentage, compared to FT and ELBW ones; also, ELBW mothers showed a lower educational level
204 compared to VLBW and FT mothers. To evaluate the effect of parental educational level, marital
205 status, parental age and parity on EPDS scores, a series of Repeated Measures Analysis of Variance
206 was performed considering time of assessment (3, 9 and 12 months) as a within-subjects factor, birth
207 weight (ELBW, VLBW and FT groups), parental gender and specific confounder variables (parental
208 educational level, marital status, parental age and parity) as between-subjects factors. The results
209 showed a non-significant interaction effect for educational level ($F_{(4,620)}=.89$; $p=.47$), for parental age
210 ($F_{(6,626)}=1.22$; $p=.30$) and for parity ($F_{(4,628)}=.77$; $p=0.54$). A significant interaction effect was found
211 considering the variable marital status in the model ($F_{(4,622)}=2.55$; $p=.04$); to better evaluate the
212 marital status effect on EPDS scores, a separate Repeated Measures ANOVA was performed for each
213 birth weight group. Results showed a significant effect of marital status by parental gender by time of
214 assessment for the FT group ($F_{(2,153)}=3.12$; $p=.04$), while no significant interaction effect was found
215 for the ELBW group ($F_{(2,63)}=.92$; $p=.40$) nor for the VLBW group ($F_{(2,93)}=2.75$; $p=.07$). Taking into
216 account these results, we included the marital status as a confounder variable in the APIM models
217 only for FT group, and, following the parsimony principle, the variable was not included in the
218 APIM models for ELBW and VLBW groups.

219 Moreover, significant differences among groups emerged for the variables strictly linked to the
220 condition of preterm birth, as expected: birth weight, gestational age, type of delivery and twinning
221 (Table 1).

222

223 3.2 Depressive symptoms according to severity of birth weight, time of assessment and 224 parental gender

225 Repeated Measures ANOVA showed a significant effect of the interaction between birth weight and
226 time of assessment ($F_{(4,646)}=3.43$, $p=.01$): specifically, ELBW parents showed the highest EPDS score
227 at T1 with a considerable decrease of depressive symptoms at T2 and T3. Conversely, despite EPDS
228 mean scores of VLBW and FT groups are lower at 9 and 12 months than those at 3 months, this
229 decrease is slight and less evident than that shown by ELBW (Table 2).

230 No significant effects were found when we considered the interaction among birth weight, time of
231 assessment and parental gender ($F_{(4,646)}=1.09$, $p=.36$).

232 When we considered the categorical scores of EPDS (depressed vs. non-depressed), a significantly
233 higher frequency of depressed parents emerged at T1 in the ELBW group compared to those of
234 VLBW and FT groups ($\chi^2=14.01$, $p=.01$) (Table 2). This result emerged also when analyses were run
235 separately for mothers ($\chi^2=9.40$, $p=.01$) and fathers ($\chi^2=7.43$, $p=.02$) (Table 2).

236 No significant differences emerged among the 3 birth weight groups at T2 and T3 (Table 2), neither
237 in the total sample, nor in mothers' and fathers' separate samples.

238

239 3.3 Reciprocal influence of depressive symptoms between mothers and fathers

Reciprocal influence of PND in preterm mothers and fathers

240 Most of the correlations among maternal and paternal EPDS at T1, T2 and T3 were significant, for
241 each birth weight group (Table 3). Overall, a high correspondence emerged between mothers' and
242 fathers' EPDS scores measured at the same time of assessment. Moreover, mothers' and fathers'
243 depression levels were correlated with their own as well as their partner' depression among the
244 different times of assessment. Results indicated that actor effect, both for mothers and fathers, as well
245 as partner effect, could be estimated.

246 An omnibus test of distinguishability has been done for both T1->T2 model and T1->T3 model to
247 test empirically the distinguishable of dyad members by parental gender. The results of the omnibus
248 test of distinguishability suggest that in our sample the members of the dyad can be considered
249 statistically distinguishable (T1-T2: $\chi^2(6)=20.54$; $p=.01$; T1-T3: $\chi^2(6)=20.54$; $p=.01$). Therefore,
250 in this study, we conclude that dyad members were distinguishable based on the variable gender.

251 The results of APIM models based on the different birth weight groups are shown in Figure 1, 2 and
252 3. Model 1 and 2 represent, respectively, the evaluation of actor-partner effects estimated on
253 depressive symptoms measured from T1 to T2 (Model 1:T1D->T2D) and those from T1 to T3
254 (Model 2:T1D->T3D).

255

256 3.3.1 ELBW group

257 *Model 1*

258 A significant actor effect was found for both mothers ($b=.45$, $p=.02$) and fathers ($b=.54$, $p=.01$). No
259 significant partner effect was found from fathers to mothers ($b=.14$, $p=.35$) nor from mothers to
260 fathers ($b=.12$, $p=.39$). The k values interpretation suggests that for both mothers ($k=.32$, 95% CI [-
261 .27; 3.86]) and fathers ($k=.22$, 95% CI [-.16; .81]) an actor-only model is plausible (Figure 1A).

262 *Model 2*

263 A significant actor effect was found for mothers ($b=.29$, $p=.02$), but not for fathers ($b=.17$, $p=.34$).
264 No significant partner effect was found from fathers to mothers ($b=.03$, $p=.86$) nor from mothers to
265 fathers ($b=.06$, $p=.68$). Interpretation of k values suggests an actor-only model both for mothers
266 ($k=.09$, 95% CI [-2.94; .88]) and fathers ($k=.38$, 95% CI [-.69; 4.38]) (Figure 1B).

267 3.3.2 VLBW group

268 *Model 1*

269 A significant actor effect was found for mothers ($b=.66$, $p=.01$), but not for fathers ($b=-.03$, $p=.78$). A
270 significant partner effect resulted both for fathers towards mothers ($b=-.21$, $p=.03$) as well as for
271 mothers towards fathers ($b=.19$, $p=.01$), meaning that fathers as well as mothers, having a highly
272 depressed partner at T1, reported themselves a higher level of depressive symptoms at T2. However,
273 the k values interpretation suggests an actor-only model ($k=0$) for mothers: the k value for mothers
274 was equal to $-.31$ with a 95% confidence interval ranging from $-.53$ to $.13$. Therefore, K parameter
275 for fathers to mothers partner effect was not performed, because the absolute standardized value of
276 the actor effects for fathers was less than 0.10 (Beta=-.03), suggesting a partner-only pattern effect
277 (Fitzpatrick et al., 2016).

Reciprocal influence of PND in preterm mothers and fathers

278 *Model 2*

279 A significant actor effect emerged for both mothers ($b=.57, p=.01$) and fathers ($b=.39, p=.01$). No
280 significant partner effect was found from fathers to mothers ($b=-.04, p=.73$) nor from mothers to
281 fathers ($b=.12, p=.17$). The k values interpretation suggests that for both mothers and fathers an
282 actor-only model is plausible ($k=-.07, 95\% \text{ CI } [-.42; .8]$; $k=.30, 95\% \text{ CI } [-.27; .65]$, respectively),
283 (Figure 2B).

284

285 **3.3.3 FT group**

286 Based on the results performed to analyze the impact of possible confounder variables, the marital
287 status has been added at the two subsequent APIM models as between-dyad covariate.

288 *Model 1*

289 Results showed a significant actor effect for both mothers ($b=.51, p=.01$) and fathers ($b=.62, p=.01$).
290 No significant partner effect was found from fathers to mothers ($b=-.005, p=.97$) nor from mothers to
291 fathers ($b=.07, p=.50$). The k values interpretation suggests that for both parents an actor-only model
292 is plausible ($k=-0.01, 95\% \text{ CI } [-.36; .70]$; $k=.11, 95\% \text{ CI } [-.19; .83]$, respectively). Marital status did
293 not significantly influence EPDS score for mothers ($b=.57, p=.32$), nor for fathers ($b=-.70, p=.20$),
294 (Figure 3A).

295 *Model 2*

296 A significant actor effect has been found for both mothers ($b=.38, p=.01$) and fathers ($b=.64, p=.01$).
297 No significant partner effect was found from fathers to mothers ($b=.03, p=.74$) nor from mothers to
298 fathers ($b=-.11, p=.27$). Interpretation of k values suggests an actor-only model for both mothers and
299 fathers ($k=.06, 95\% \text{ CI } [-.31; .60]$; $k=-.17, 95\% \text{ CI } [-.38; .13]$, respectively). The covariate did not
300 significantly influence the EPDS score for mothers ($b=.42, p=.41$), nor for fathers ($b=-.55, p=.30$),
301 (Figure 3B).

302

303 **4 Discussion**

304 This study aimed to explore the impact of the severity of prematurity on parental PND during the
305 first year after childbirth. One strength of this study was the focus on both mothers and fathers and,
306 specifically, on the reciprocal influence of depressive symptoms between partners in a high-risk
307 context represented by the parental adjustment after a preterm birth. To our knowledge, no previous
308 studies have investigated this topic.

309 First, we compared depressive symptoms in ELBW, VLBW and FT parents during the first year
310 postpartum. Prematurity is widely recognized as a relevant risk factor for parental PND (Miles et al.,
311 2007; Vigod et al., 2010; Pace et al., 2016) and our study confirmed significantly higher levels of
312 postnatal depressive symptoms in the first months, but only for parents of more severe preterm babies
313 (ELBW). In the other preterm group, VLBW, parents showed low and stable levels of depressive
314 symptoms from 3 to 12 months, similar to FT parents. This result stresses the relevance to distinguish
315 among different preterm populations in research and clinical intervention. Indeed, parents' mental

Reciprocal influence of PND in preterm mothers and fathers

316 state may be especially impaired in case of higher severity of prematurity, and this is supported by
317 our previous studies (Agostini et al., 2014; Neri et al., 2015, 2020). For ELBW parents, the first
318 postpartum trimester can represent a highly vulnerable period due to baby's health issues and the
319 parental adjustment after discharge from NICU and these factors do play a key role in increasing the
320 risk for PND (Pignon, 2017; Grunberg et al., 2019).

321 An unexpected result concerns the similarity between mothers and fathers regarding both levels and
322 frequency of PND in all birth weight groups, according to the time of assessment. While previous
323 literature has widely underlined a higher level of depression and a higher prevalence, in the perinatal
324 period, of depressed mothers compared to fathers (Matthey et al., 2000; Vismara et al., 2016;
325 Chhabra et al., 2020), we did not find significant differences. This result may suggest that the
326 parental adjustment after a preterm birth similarly characterizes both parents, as fathers also may be
327 more actively engaged (Provenzi et al., 2016; Stefana and Lavelli, 2017), reducing gender
328 differences.

329

330 The second aim of the study was to fit an APIM to investigate, for each birth weight group, whether
331 and how the level of depression at 3 months of each partner was associated to own level of
332 depressive symptoms (that is, actor effect) and to the partner's levels of depressive symptoms (that is,
333 partner effect) at 9 and at 12 months postpartum.

334 According to actor effects, we found a significant association between mothers' depressive
335 symptoms at 3 months postpartum and those experienced at both 9 and 12 months: this result
336 emerged for every birth weight group, that is mothers of preterm and full-term infants, suggesting
337 that the first postpartum months play a crucial role for the depressive risk during the subsequent
338 months. When fathers were considered, actor effects on outcomes at both 9 months and 12 months
339 were observed only for the FT group. Taken together, these results could open up the possibility of
340 identifying sub-groups of mothers and fathers with a higher risk of chronicity since the first
341 postpartum trimester, in line with recent literature (Baron et al., 2017; Santos et al., 2017; Barkmann
342 et al., 2018), enhancing the possibility to promptly implement screening programs as well as
343 therapeutic support for parents. These actions would decrease the risk of negative consequences of
344 chronic depression on infant's physical and mental health.

345 Conversely, for preterm fathers, significant actor effects were found only for the association between
346 scores at 3 and 9 months, in case of ELBW infants, and between 3 to 12 months for VLBW group.
347 These findings suggest some considerations. In the case of ELBW group, it may be possible that the
348 severity of the condition makes fathers more vulnerable to depressive symptomatology also at 9
349 months, especially in case of PND during the first months. Conversely, no significant associations
350 were observed at 12 months, a time point usually characterized by infant's achievement of new
351 important skills (i.e. deambulation and/or first words), allowing him/her to be more autonomous. It
352 may be possible that, due to a change in fathers' representation of their infant, from a "fragile" baby
353 hospitalized in the NICU to a more healthy and competent infant, fathers may feel reassured and
354 more comfortable in their parenting role, with a positive effect on their affective state.

355 Regarding the case of VLBW group, the actor effect that we observed in VLBW fathers represents a
356 quite unexpected result. While the association between PND scores at 3 and 12 months would
357 suggest a long-term effect of early symptomatology, the absence of a significant effect at 9 months
358 undermines the plausibility of this explanation. Taken together, these results showed an unclear

Reciprocal influence of PND in preterm mothers and fathers

359 profile of PND in VLBW fathers, suggesting that also other variables could influence paternal EPDS
360 scores both at 9 and 12 months. Given the lack of studies on PND in preterm infants' fathers, we
361 recommend to develop further studies to deeply explore the effect of risk factor in the maintaining
362 stable, improving or worsening of PND in these fathers.

363 When partner effects were considered, a significant association emerged in VLBW group, where
364 paternal PND at 9 months was significantly influenced by maternal depression at 3 months (partner
365 effect). Some studies have underlined how the prolonged hospitalization of the baby, and quite often
366 of the mother, may weigh on fathers, especially in the case of VLBW, because of the active role is
367 expected from them in supporting the partner and taking care of the baby (Provenzi et al., 2016;
368 Stefana and Lavelli, 2017). In this context, having a depressed partner could represent an additional
369 factor of pressure for fathers, leading to an increase in distress and depressive symptoms (Chhabra et
370 al., 2020).

371 In all other conditions no significant partner effect between maternal and paternal PND emerged. The
372 absence of partner effect in ELBW group may suggest that the higher severity of these infants may
373 represent a traumatic event, where both parents experience more frequently overwhelming negative
374 feelings. For this reason, parents might react by emotionally distancing themselves, and becoming
375 less sensitive to affective states of their partners, with a subsequent absence of significant partner
376 effect.

377 In our study, a similar reaction could be hypothesized for mothers of VLBW infants. The present
378 results may suggest that VLBW fathers have an active involvement in the care of their infant and
379 their partner, while mothers, as those of ELBW infants, are often more overwhelmed by feelings of
380 sadness, guilt, and failure, as already underlined by literature (Shah et al., 2011; Loomotey et al.,
381 2020), may be highly self-absorbed in their suffering and more detached from their partner.

382 Taken together, these results seem to confirm that ELBW and VLBW parents may differ in the way
383 they cope with the potentially traumatic experience of a preterm childbirth. Furthermore, even if we
384 did not find any influence of parents' gender, these results may suggest that mothers and fathers are
385 characterized by specific reactions and adaptations to their infant's level of prematurity.

386 Finally, it should be noted that also the results on FT parents showed no reciprocal influence between
387 mothers and fathers. Although we found significant correlations between maternal and paternal
388 EPDS scores, confirming previous literature (Ramchandani et al., 2005; Anding et al., 2016; Vismara
389 et al., 2016; Canario and Figueredo, 2017; Kiviruusu et al., 2020), the interdependence between
390 partners did not emerge anymore when we used a more appropriate statistical model (APIM).
391 Furthermore, it is to note that maternal and paternal PND were usually investigated using cross-
392 sectional research studies (Anding et al., 2016; Vismara et al., 2016; Canario and Figueredo, 2017),
393 while in this study the APIM was performed in a longitudinal design.

394 In summary, the results seem to suggest a specificity of maternal and paternal affective responses to
395 preterm birth, where the influence of a partner's symptomatology on the other's symptoms is only
396 partially present (Johansson et al., 2012; Molgora et al., 2017; Canzi et al., 2019).

397 Some limits of the study may be acknowledged. First, the results need to be confirmed on larger
398 samples, also considering a similar size among groups. Second, in the present study we assessed
399 PND through a self-report questionnaire (EPDS): given the limitations of this kind of measure, it may
400 be useful to replicate the study using a clinical interview, in order to diagnose the depressive
401 condition. We may add some more detailed considerations on the use of EPDS. The international

Reciprocal influence of PND in preterm mothers and fathers

402 literature on the psychometric characteristics of this instrument has underlined how, regarding the
403 fathers' population, the EPDS would show a different factor structure from the EPDS used on
404 mothers. In fact, as reported by previous studies (Matthey, 2008; Massoudi et al., 2013), the EPDS
405 for fathers seems more appropriate in detecting a general level of distress given by anxiety,
406 unhappiness and worry. In the Italian version for fathers by Loscalzo et al. (2015), this aspect has
407 been confirmed by a factorial structure characterized by a most prevalent factor, concerning items on
408 unhappiness and anxiety, and only a small portion of the variance explained by a "depressive core".
409 These characteristics of EPDS could possibly explain why, in our samples, we found very low
410 prevalence rates of clinically depressed fathers. As already put in evidence by Matthey & Agostini
411 (2017), all these findings support the evidence that: 1) probably this kind of general distress is a more
412 typical expression of emotional maladjustment in men in the first postpartum months, compared to
413 women; 2) considering that the EPDS is the same for both genders, it may be less suited for the
414 identification of perinatal depression in fathers; 3) there is the need to further analyze the
415 psychometric properties of the EPDS for men.

416 Taking into account these limitations on the use of EPDS, we underline also the fact that, up to now,
417 the EPDS is the only validated measure available for both mothers and fathers and specifically aimed
418 at detecting the perinatal depressive symptomatology; besides, using the same instrument for both
419 genders, we enable in this study the comparison between the two samples and the comparison with
420 all the massive international literature published on EPDS since 1987.

421 Another limitation of the study was that we evaluated parental PND longitudinally, but no specific
422 analyses were run to identify the trajectories of symptomatology, as suggested by recent literature
423 (Paulson et al., 2016; Fredriksen et al., 2019; Narayanan and Naerde, 2019; Volling et al., 2019).
424 Also, in our study we did not investigate anxious symptoms, which are known to occur often in
425 comorbidity with depression and may represent the difficulties in parental adjustment after a preterm
426 birth (Chhabra et al., 2020; Mutua et al., 2020).

427 Future studies are needed to confirm the results also controlling for the effect of other variables, such
428 as specific characteristics of parental couples (e.g. quality of dyadic relationship, social support),
429 which may interact with parental PND (Don et al., 2012; Rollè et al., 2017). Besides, it would be
430 relevant to study the possible implications of maternal and paternal PND on the quality of caregiving.

431 Globally, this study suggests that the preterm birth represents a very specific scenario in the transition
432 to parenthood, leading to possibly different affective reactions in mothers and fathers for what
433 concerns depressive symptomatology. Given the paucity of the research on the reciprocity between
434 maternal and paternal PND in prematurity, these results may shed new light on this field but would
435 benefit of a confirmation by further studies.

436

437 **AUTHOR CONTRIBUTIONS**

438 EN prepared the study design, organized the sample recruitment, collected data, and contributed to
439 the writing of all sections of the manuscript. SG and FG performed statistical analysis, prepared the
440 tables, and contributed to write the manuscript's methods, results and references sections. MB and
441 MS contributed to prepare the study design and supervised data collection and the research team. FA
442 prepared the study design, supervised all the phases of the research study and contributed to the
443 writing of all the sections of the manuscript.

444 All authors reviewed and approved the manuscript for publication.

445

446

447 **The authors declare no conflict of interest or financial interest to disclose.**

448

449 **References**

- 450 Agostini, F., Neri, E., Dellabartola, S., Biasini, A., and Monti, F. (2014). Early interactive behaviours
451 in preterm infants and their mothers: Influences of maternal depressive symptomatology and neonatal
452 birth weight. *Infant Behav. Dev.* 37:1, 86-93. doi: 10.1016/j.infbeh.2013.12.003
- 453 Anding, J. E., Röhrle, B., Grieshop, M., Schücking, B., and Christiansen, H. (2016). Couple
454 comorbidity and correlates of postnatal depressive symptoms. *J. Affect. Disord.* 190, 300-309.
455 doi:10.1016/j.jad.2015.10.033
- 456 Ayinde, O., and Lasebikan, V.O. (2017). Factors associated with paternal perinatal depression in
457 fathers of newborns in Nigeria. *J. Psychosom Obstet Gynecol.* 1-9. doi:
458 10.1080/0167482X.2017.1398726
- 459 Barkmann, C., Helle, N., and Bindt, C. (2018). Is very low infant birth weight a predictor for five-
460 year course of depression in parents? A latent growth curve model. *J. Affect. Disord.* 229, 415–420.
461 doi: 10.1016/j.jad.2017.12.020
- 462 Baron, E., Bass, J., Murray, S.M., Schneider, M., and Lund, C. (2017). A systematic review of
463 growth curve mixture modelling literature investigating trajectories of perinatal depressive symptoms
464 and associated risk factors. *J. Affect. Disord.* 223, 194-208. doi: 10.1016/j.jad.2017.07.046
- 465 Benvenuti, P., Ferrara, M., Niccolai, C., Valoriani, V., and Cox, J.L. (1999). The Edinburgh Postnatal
466 Depression Scale: validation for an Italian sample. *J. Affect. Disord.* 53:2, 137–141. doi:
467 10.1016/S0165-0327(98)00102-5
- 468 Bowen, A., Bowen, R., Butt, P., Rahman, K., and Muhajarine, N. (2012). Patterns of depression and
469 treatment in pregnant and postpartum in women. *Can. J. Psychiatry.* 57:3, 161–167. doi:
470 10.1177/070674371205700305
- 471 Cameron, E.E., Sedov, I.D., and Tomfohr-Madsen, L.M. (2016). Prevalence of paternal depression in
472 pregnancy and the postpartum: An updated meta-analysis. *J. Affect. Disord.* 206, 189-203. doi:
473 dx.org/10.1016/j.jad.2016.07.044
- 474 Canario, C., and Figueredo, B. (2017). Anxiety and depressive symptoms in women and men from
475 early pregnancy to 30 months postpartum. *J. Reprod. Infant Psychol.* 1-19. doi:
476 10.1080/02646838.2017.1368464
- 477 Canzi, E., Molgora, S., Fenaroli, V., Rosnati, R., Saita, E., & Ranieri, S. (2019). “Your stress is my
478 stress”: A dyadic study on adoptive and biological first-time parents. *Couple and Family Psychology:
479 Research and Practice*, 8(4), 197–207. <https://doi.org/10.1037/cfp0000127>
- 480 Cheng, E. R., Kotelchuck, M., Gerstein, E. D., Taveras, E. M., and Poehlmann-Tynan, J. (2016).
481 Postnatal Depressive Symptoms Among Mothers and Fathers of Infants Born Preterm: Prevalence
482 and Impacts on Children's Early Cognitive Function. *J Dev Behav Pediatr*, 37:1, 33–42.
483 <https://doi.org/10.1097/DBP.0000000000000233>
- 484 Chhabra, J., McDermott, B., and Li, W. (2020). Risk factors for paternal perinatal depression and
485 anxiety: a systematic review and meta-analysis. *Psychol. Men Mascul.* doi: 10.1037/men0000259
- 486 Cook, W.L., and Kenny, D. A. (2005). The Actor–Partner Interdependence Model: A model of
487 bidirectional effects in developmental studies. *Int. J. Behav. Dev.* 29:2, 101-109. doi:
488 10.1080/01650250444000405
- 489 Cox, J. (2019). Thirty years with the Edinburgh Postnatal Depression Scale: voices from the past and
490 recommendations for the future. *Br J Psychiatry*, 214:3, 127-129. doi: 10.1192/bjp.2018.245

Reciprocal influence of PND in preterm mothers and fathers

- 491 Cox, J., Holden, J., and Sagovsky, R. (1987). Detection of postnatal depression: development of the
492 10 item Edinburgh Postnatal Depression Scale. *Br. J. Psychiatry.* 150, 782–
493 786. doi:10.1192/bjp.150.6.782
- 494 Da Costa, D., Danieli, C., Abrahamowicz, M., Dasgupta, K., Sewitch, M., Lowensteyn, I., et al.
495 (2019). A prospective study of postnatal depressive symptoms and associated risk factors in first-time
496 fathers. *J. Affect. Disord.* 249, 371-377. doi: 10.1016/j.jad.2019.02.033
- 497 Don, B. P., and Mickelson, K. D. (2012). Paternal Postpartum Depression: The Role of Maternal
498 Postpartum Depression, Spousal Support, and Relationship Satisfaction. *Couple and Family*
499 *Psychology: Research and Practice.* Advance online publication. doi:10.1037/a0029148
- 500 Enders, C.K., and Bandalos, D.L. (2001). The Relative Performance of Full Information Maximum
501 Likelihood Estimation for Missing Data in Structural Equation Models. *Struct. Equ. Modeling.* 8:3,
502 430-457.
- 503 Escriba-Aguir, V., and Artazcoz, L. (2011). Gender differences in postpartum depression: a
504 longitudinal cohort study. *J. Epidemiol. Community Health.* 65:4, 320-325.
505 doi:10.1136/jech.2008.085894
- 506 Evans, J., Heron, J., Francombe, H., Oke, S., Golding, J., and on behalf of the Avon Longitudinal
507 Study of Parents and Children Study Team. (2001). Cohort study of depressed mood during
508 pregnancy and after childbirth. *BMJ.* 323:7307, 257–260. doi: 10.1136/bmj.323.7307.257
- 509 Fitzpatrick, J., Gareau, A., Lafontaine, M.F., and Gaudreau, P. (2016). How to Use the Actor-Partner
510 Interdependence Model (APIM) To Estimate Different Dyadic Patterns in MPLUS: A Step-by-Step
511 Tutorial. *Quant Methods Psychol.* 12:1, 74-86.
- 512 Fredriksen, E., von Soest, T., Smith, L., and Moe, V. (2019). Parenting Stress Plays a Mediating Role
513 in the Prediction of Early Child Development from Both Parents' Perinatal Depressive Symptoms. *J.*
514 *Abnorm. Child Psychol.* 47, 149-164.
- 515 Gavin, N.I., Gaynes, B.N., Lohr, K.N., Meltzer-Brody, S., Gartlehner, G., and Swinson, T. (2005).
516 Perinatal depression: a systematic review of prevalence and incidence. *Obstet. Gynecol.* 106, 1071–
517 1083. doi: 10.1097/01.AOG.0000183597.31630.db
- 518 Gray, P.H., Edwards, D.M., O'Callaghan, M. J., and Cuskelly, M. (2012). Parenting stress in mothers
519 of preterm infants during early infancy. *Early Hum. Dev.* 88, 45–49. doi:
520 10.1016/j.earlhumdev.2011.06.014
- 521 Grunberg, V.A., Geller, P.A., Bonacquisti, A., Patterson, C.A. (2019). NICU infant health severity
522 and family outcomes: a systematic review of assessments and findings in psychosocial research. *J*
523 *Perinatol.* 39, 156-172. doi: 10.1038/s41372-018-0282-9
- 524 Hahn-Holbrook, J., Cornwell-Hinrichs, T., and Anya, I. (2018). Economics and health predictors of
525 national postpartum depression prevalence: a systematic review, meta-analysis, and meta-regression
526 of 291 studies from 56 countries. *Front. Psychiatry.* 8:248, 1-23. doi: 10.3389/fpsy.2017.00248
- 527 Helle, N., Barkmann, C., Bartz-Seel, J., Diehl, T., Ehrhardt, S., Heldel, A., et al. (2015). Very low
528 birth-weight as a risk factor for postpartum depression four to six weeks postbirth in mothers and
529 fathers: Cross-sectional results from a controlled multicentre cohort study. *J. Affect. Disord.*, 180,
530 154-161. doi: 10.1016/j.jad.2015.04.001
- 531 Ierardi, E., Ferro, V., Trovato, A., Tambelli, R., and Riva Crugnola, C. (2019). Maternal and paternal
532 depression and anxiety: their relationship with mother-infant interactions at 3 months. *Arch.*
533 *Womens. Ment. Health.* 22, 527-533.

Reciprocal influence of PND in preterm mothers and fathers

- 534 Johansson, M., Rubertsson, C., Radestad, I., and Hildingsson, I. (2012). Childbirth – An
535 emotionally demanding experience for fathers. *Sex. Reprod. Health Care.* 3:1, 11-20. doi:
536 10.1016/j.srhc.2011.12.003
- 537 Kenny, D.A. (2012). Dyadic data analysis: Chapter 7 elaborations. Retrieved from
538 <http://davidakenny.net/kkc/c7/c7.htm>
- 539 Kenny, D.A., and Ledermann, T. (2010). Detecting, measuring, and testing dyadic patterns in the
540 actor–partner interdependence model. *J. Fam. Psychol.* 24:3, 359-366. doi: 10.1037/a0019651
- 541 Kenny, D.A., Kashy, D.A., and Cook, W.L. (2006). *Dyadic Data Analysis*. New York: The Guilford
542 Press.
- 543 Kerstis, B., Engström, G., Edlund, B., and Aarts, C. (2013). Association between mothers' and
544 fathers' depressive symptoms, sense of coherence and perception of their child's temperament in early
545 parenthood in Sweden. *Scand. J. Public Health.* 41, 233-239. doi: 10.1177/1403494812472006
- 546 Kivuruusu, O., Pietikäinen, J.T., Kylliäinen, A., Pölkki, P., Saarenpää-Heikkilä, O., Marttunen, M., et
547 al. (2020). Trajectories of mothers' and fathers' depressive symptoms from pregnancy to 24 months
548 postpartum. *J. Affect. Disord.* 260, 629:637. doi: 10.1016/j.jad.2019.09.038
- 549 Lasiuk, G.C., Comeau, T., and Newburn-Cook, C. (2013). Unexpected: an interpretive description of
550 parental traumas' associated with preterm birth. *BMC Pregnancy Childb.* 13, S13. doi:
551 10.1186/1471-2393-13-s1-s13
- 552 Loomotey, A.Y., Bam, V., Diji, A.K., Asante, E., Asante, B.A., and Osei, J. (2020). Experiences of
553 mothers with preterm babies at a Mother and Baby Unit of a tertiary hospital: A descriptive
554 phenomenological study. *Nurs. Open.* 7, 150-159. doi: 10.1002/nop2.373
- 555 Loscalzo, Y., Giannini, M., Contena, B., Gori, A., and Benvenuti, P. (2015). The Edinburgh
556 Postnatal Depression Scale for Fathers: a contribution to the validation for an Italian sample. *Gen.
557 Hosp. Psychiatry.* 37:3, 251– 256. doi: 10.1016/j.genhosppsy.2015.02.002
- 558 Massoudi, P., Hwang, C. P., & Wickberg, B. (2013). How well does the Edinburgh Postnatal
559 Depression Scale identify depression and anxiety in fathers? A validation study in a population based
560 Swedish sample. *J. Affect. Disord.*, 149(1-3), 67-74. doi: 10.1016/j.jad.2013.01.005
- 561 Matthey, S. (2008). Using the Edinburgh Postnatal Depression Scale to Screen for Anxiety
562 Disorders. *Depression and Anxiety*, 25(11), 926-931. doi: 10.1002/da.20415
- 563 Matthey, S., & Agostini, F. (2017). Using the Edinburgh Postnatal Depression Scale for women and
564 men-some cautionary thoughts. *Arch. Womens. Ment. Health.*, 20(2), 345-354. doi: 10.1007/s00737-
565 016-0710-9
- 566 Matthey, S., Barnett, B., Kavanagh, D. J., & Howie, P. (2001). Validation of the Edinburgh Postnatal
567 Depression Scale for men, and comparison of item endorsement with their partners. *J. Affect. Disord.*
568 64(2), 175-184. doi: [https://doi.org/10.1016/S0165-0327\(00\)00236-6](https://doi.org/10.1016/S0165-0327(00)00236-6)
- 569 Matthey, S., Barnett, B., Ungerer, J., and Waters, B. (2000). Paternal and maternal depressed mood
570 during the transition to parenthood. *J. Affect. Disord.* 60: 2, 75–85. doi: 10.1016/S0165-
571 0327(99)00159-7
- 572 Matthey, S., Fisher, J., & Rowe, H. (2013). Using the Edinburgh postnatal depression scale to screen
573 for anxiety disorders: Conceptual and methodological considerations. *J. Affect. Disord.*, 146(2), 224-
574 230. doi: 10.1016/j.jad.2012.09.009

Reciprocal influence of PND in preterm mothers and fathers

- 575 Mehler, K., Mainusch, A., Hucklenbruch-Rother, E., Hahn, M., Hünseler, C., & Kribs, A. (2014).
576 Increased rate of parental postpartum depression and traumatization in moderate and late preterm
577 infants is independent of the infant's motor repertoire. *Early Hum. Dev.*, 90(12), 797-801. doi:
578 <https://doi.org/10.1016/j.earlhumdev.2014.09.008>
- 579 Mehler, K., Wendrich, D., Kissgen, R., Roth, B., Oberthuer, A., Pillekamp, F., et al. (2011). Mothers
580 seeing their VLBW infants within 3 h after birth are more likely to establish a secure attachment
581 behavior: evidence of a sensitive period with preterm infants? *J. Perinatol.* 31, 404–410. doi:
582 10.1038/jp.2010.139
- 583 Miles, M. S., Holditch-Davis, D., Schwartz, T. A., and Scher, M. (2007). Depressive symptoms in
584 mothers of prematurely born infants. *J. Dev. Behav. Pediatr.* 28, 36–44. doi:
585 10.1097/01.DBP.0000257517.52459.7a
- 586 Molgora, S., Fenaroli, V., Margaroli, M., and Saita, M. (2017). Trajectories of postpartum depression
587 in Italian first-time fathers. *Am. J. Mens Health.* 11:4, 880-887. doi: 10.1177/1557988316677692
- 588 Monzon, C., Lanza di Scalea, T., and Pearlstein, T. (2014). Postpartum psychosis: updates and
589 clinical issues. *Physicians Practice.* 1-6.
- 590 Mutua, J. Kigamwa, P., Ng'ang'a, P., Tele, A., and Kumar, M. (2020). Comorbid postpartum anxiety
591 and depression and associated factors in mothers with pre-term births: a descriptive comparative
592 study. *Research Square.* 1-18.
- 593 Narayanan, M.K., and Naerde, A. (2016). Associations between maternal and paternal depressive
594 symptoms and early child behavior problems: testing a mutually adjusted prospective longitudinal
595 model. *J. Affect. Disord.* 196, 181-189.
- 596 Neri, E., Agostini, F., Salvatori, P., Biasini, A., and Monti, F. (2015). Mother-preterm infant
597 interactions at 3 months of corrected age: influence of maternal depression, anxiety and neonatal
598 birth weight. *Front. Psychol.* 6, 1-12. doi: 10.3389/fpsyg.2015.01234
- 599 Neri, E., Genova, F., Monti, F., Trombini, E., Biasini, A., Stella, M., et al. (2020). Developmental
600 dimensions in preterm infants during the 1st year of life: the influence of severity of prematurity and
601 maternal generalized anxiety. *Front. Psychol.* 11: 445, 1-17. doi: 10.3389/fpsyg.2020.00455
- 602 Nishimura, A., Fujita, Y., Katsuta, M., Ishihara, A., and Ohashi, K. (2015). Paternal
603 postnatal depression in Japan: an investigation of correlated factors including relationship with a
604 partner. *BMC Pregnancy Childb.* 15: 128, 1-8. doi: 10.1186/s12884-015-0552-x
- 605 O'Donovan, A., and Nixon, E. (2019). “Weathering the storm:” Mothers’ and fathers’ experiences of
606 parenting a preterm infant. *Infant Mental Health Journal*, 40(4), 573-587. doi: 10.1002/imhj.21788
- 607 Pace, C.C., Splitte, A.J., Molesworth, C.M., Lee, K.J., Northam, E.A., Cheong, J.L., et al. (2016).
608 Evolution of depression and anxiety symptoms in parents of very preterm infants during the newborn
609 period. *JAMA Pediatr.* 170:9, 863-870. doi: 10.1001/jamapediatrics.2016.0810
- 610 Patel, M., Bailey, R.K., Jabeen, S., Ali, S., Barker, N.C., and Osiezagha, K. (2012). Postpartum
611 depression: a review. *J. Health Care Poor Underserved.* 23:2, 534–542. doi: 10.1353/hpu.2012.0037
- 612 Paulson, J.F., and Bazemore, S.D. (2010). Prenatal and postpartum depression in fathers and its
613 association with maternal depression: a meta-analysis. *JAMA.* 303:19, 1961–1969. doi:
614 10.1001/jama.2010.605.
- 615 Paulson, J.F., Bazemore, S.D., Goodman, J.H., and Leiferman, J.A. (2016). The course and
616 interrelationship of maternal and paternal perinatal depression. *Arch. Womens Ment. Health.* 19:4,
617 655-663. doi: 10.1007/s00737-016-0598-4

Reciprocal influence of PND in preterm mothers and fathers

- 618 Pignon, A. (2017). What happens at the NICU? Parents experience of caring for their premature
619 infants at home. *Occup. Therapy Comm.* 2:1, 1-9.
- 620 Pisoni, C., Spairani, S., Manzoni, F., Ariaudo, G., Naboni, C., Moncecchi, M., et al. (2019).
621 Depressive symptoms and maternal psychological distress during early infancy: a pilot study in
622 preterm as compared with term mother–infant dyads. *J. Affect. Disord.* 257, 470-476.
- 623 Provenzi, L., Barello, S., Fumagalli, M., Graffignalda, G., Sirgiovanni, I., Savarese, M., et al. (2016).
624 A comparison of maternal and paternal experiences of becoming parents of a very preterm infant. *J.*
625 *Obstet. Gynecol. Neonatal Nurs.* 45:4, 528-541. doi: 10.1016/j.jogn.2016.04.004
- 626 Quist, M., Kaciroti, N., Poehlmann-Tynan, J., Weeks, H. M., Asta, K., Singh, P., & Shah, P. E.
627 (2019). Interactive Effects of Infant Gestational Age and Infant Fussiness on the Risk of Maternal
628 Depressive Symptoms in a Nationally Representative Sample. *Acad Pediatr*, 19(8), 917-924. doi:
629 S1876-2859(18)30541-2 [pii]10.1016/j.acap.2019.02.015
- 630 Ramchandani, P., Stein, A., Evans, J., O'Connor, T.G., and the ALSPAC study team. (2005).
631 Paternal depression in the postnatal period and child development: a prospective population study.
632 *Lancet.* 365, 2201– 2205.
- 633 Rollè, L., Prino, L.E., Sechi, C., Vismara, L., Neri, E., Polizzi, C., et al. (2017). Parenting Stress,
634 Mental Health, Dyadic Adjustment: A Structural Equation Model. *Front. Psychol.* 8:839. doi:
635 10.3389/fpsyg.2017.00839
- 636 Rosseel, Y. (2012). Lavaan: an R package for structural equation modeling and more. Version 0.5–12
637 (BETA). *J. Stat. Softw.* 1-37.
- 638 Santos, H., Tan, X., and Salomon, R. (2017). Heterogeneity in perinatal depression: how far have we
639 come? A systematic review. *Arch. Womens Ment. Health.* 20, 11–23.
- 640 Shah, P.E., Clements, M., and Poehlmann, J. (2011). Maternal resolution of grief after preterm birth:
641 implications for infant attachment security. *Pediatrics.* 127, 284-292. doi: 10.1542/peds.2010-1080
- 642 Shorey, S., Yin Ing Chee, C., Debby Ng, E., Chan, Y.H., Wai San Tam, W., and Chong, Y.S. (2018).
643 Prevalence and incidence of postpartum depression among healthy mothers: a systematic review and
644 meta-analysis. *J. Affect. Disord.* 104, 235-248. doi: 10.1016/j.jpsychires.2018.08.001
- 645 Stas, L., Kenny, D.A., Mayer, A., and Loeyts, T. (2018). Giving dyadic data analysis away: a user
646 friendly app for actor–partner interdependence models. *Pers. Relatsh.* 25:1, 103-119. doi:
647 10.1111/pere.12230
- 648 Stefana, A., and Lavelli, M. (2017). Parental engagement and early interactions with preterm infants
649 during the stay in the Neonatal Intensive Care Unit: protocol of a mixed-method and longitudinal
650 study. *BMJ Open.* 7, 1-8. doi: 10.1136/bmjopen-2016-013824
- 651 Treyvaud, K. (2014). Parent and family outcomes following very preterm or very low birth weight
652 birth: a review. *Semin. Fetal. Neonatal. M.* 19, 131-135. doi: 10.1016/j.siny.2013.10.008
- 653 Vigod, S.N., Villegas, L., Dennis, C.L., and Ross, L.E. (2010). Prevalence and risk factors for
654 postpartum depression among women with preterm and low-birth-weight infants: a systematic
655 review. *BJOG.* 117:5, 540–550. doi: 10.1111/j.1471-0528.2009.02493.x
- 656 Vismara, L., Rollè, L., Agostini, F., Sechi, C., Fenaroli, V., Molgora, S., et al. (2016). Perinatal
657 parenting stress, anxiety, and depression outcomes in first-time mothers and fathers: a 3- to 6-months
658 postpartum follow-up study. *Front. Psychol.* 7, 1-10. doi: 10.3389/fpsyg.2016.00938.

Reciprocal influence of PND in preterm mothers and fathers

- 659 Volling, B.L., Yu, T., Gonzalez, R., Tengelitsch, E., and Stevenson, M.M. (2019). Maternal and
660 paternal trajectories of depressive symptoms predict family risk and children's emotional and
661 behavioral problems after the birth of a sibling. *Dev. Psychopathol.* 31:4, 1307-1324. doi:
662 10.1017/S0954579418000743
- 663 World Health Organization (2012). *Born Too Soon: The Global Action Report on Preterm Birth.*
664 Geneva: World Health Organization.
- 665 Wynter, K., Rowe, H., and Fisher, J. (2013). Common mental disorders in women and men in the
666 first six months after the birth of their first infant: a community study in Victoria, Australia. *J. Affect.*
667 *Disord.* 151:3, 980-985. doi: 10.1016/j.jad.2013.08.021
- 668 Xu, F., Sullivan, E., Binns, C., and Homer, C.S.E. (2016). Mental disorders in new parents before
669 and after birth: a population-based cohort study. *BJPsych. open.* 2:3, 233-243. doi:
670 10.1192/bjpo.bp.116.002790
- 671

Reciprocal influence of PND in preterm mothers and fathers

672

673 Table 1. Parents and infant characteristics according to categories of birth weight.

	ELBW (n=38)	VLBW (n=56)	FT (n=83)	F/ χ^2
Parental characteristics				
Maternal Age				2.95
Mean (SD) <i>in years</i>	34.54±5.15	35.14±5.47	33.07±4.87	
Paternal Age				2.00
Mean (SD) <i>in years</i>	36.95±5.11	37.49±5.75	35.68±5.25	
Maternal Education, n (%)				7.33*
Primary and Secondary school	9 (25%)	4 (7.3%)	8 (9.6%)	
High school and University	27 (75%)	51 (92.7%)	75 (90.4%)	
Paternal Education, n (%)				5.93
Primary and Secondary school	14 (38.9%)	9 (16.4%)	20 (24.4%)	
High school and University	22 (61.1%)	46 (83.6%)	62 (75.6%)	
Marital status, n (%)				.69
Married	20 (54.1%)	32 (57.1%)	50 (61.7%)	
Other	17 (45.9%)	24 (42.9%)	31 (38.3%)	
Parity, n (%)				17.24**
Primiparous	30 (78.9%)	33 (58.9%)	73 (89%)	
Multiparous	8 (21.1%)	23(41.1%)	9 (11%)	
Infant characteristics				
Gender, n (%)				3.34
Male	19 (50%)	36 (64.3%)	41 (49.4%)	
Female	19 (50%)	20 (35.7%)	42 (50.6%)	
Birth weight				1173.87**
Mean (SD) <i>in grams</i>	818.89±122.63	1305.50±145.22	3489.87±456.66	
Gestational age				987.24**
Mean (SD) <i>in weeks</i>	27.29±1.99	30.21±2.11	40.04±1.09	
Type of delivery, n (%)				40.46**
Spontaneous	10 (28.6%)	14 (26.4%)	63 (75.9%)	
Caesarean section	25 (71.4%)	39 (73.6%)	20 (24.1%)	
Twinning, n (%)				21.19**
Yes	4 (10.5%)	16 (28.6%)	2 (2.4%)	
No	34 (89.5%)	40 (71.4%)	81 (97.6%)	

674 * p≤.05

675 **p≤.01

676

677 Table 2. EPDS mean and categorical scores according to birth weight, time of assessment and parental gender

	BW x Time of Assessment			BW x Time of Assessment x Parental Gender						F	
	T1	T2	T3	Mothers			Fathers			BW x Time of Assessment	BW x Time of Assessment x Parental Gender
				T1	T2	T3	T1	T2	T3		
EPDS Mean scores^a										3.43**	1.09
ELBW	6.64 ±.49	4.84 ±.44	3.87 ±.41	7.83 ±.70	5.71 ±.62	4.11 ±.58	5.46 ±.70	3.97 ±.62	3.63 ±.58		
VLBW	4.92 ±.42	4.10 ±.37	4.00 ±.35	5.66 ±.59	4.44 ±.52	4.32 ±.49	4.19 ±.60	3.75 ±.53	3.69 ±.50		
FT	4.94 ±.33	4.43 ±.29	3.92 ±.27	5.19 ±.45	4.76 ±.40	4.19 ±.38	4.70 ±.47	4.10 ±.41	3.65 ±.39		
EPDS > cut-off^b										χ^2	
ELBW	20(26.3)	8(10.5)	5(6.6)	15(39.5)	6 (15.8)	5 (14.3)	5(13.2)	2 (5.3)	0 (0.0)	14.01**	/
VLBW	15(13.4)	6(5.4)	9(8.0)	10(17.9)	6 (11.8)	8 (14.5)	5(8.9)	0 (0.0)	1 (1.9)	1.38	/
FT	14(8.4)	12(7.2)	7(4.2)	13(15.7)	8 (9.6)	6 (7.2)	1(1.2)	4 (4.9)	1 (1.3)	1.98	/

678 Legend: BW= birth weight; T1=3 months; T2=9 months; T3=12 months.

679 ^a Values are mean±SD.

680 ^b Values are n (%).

681

682 * p≤.05

683 **p≤.01

684 Table 3. Pearson correlation analysis on EPDS scores at T1, T2 and T3 in mothers and fathers
 685 according to birth weight

686

		<i>Mothers</i>			<i>Fathers</i>		
		EPDS T1	EPDS T2	EPDS T3	EPDS T1	EPDS T2	EPDS T3
ELWB	EPDS T1	1	.55**	.38*	.48**	.49**	.21
	<i>Mothers</i> EPDS T2		1	.64**	.38*	.54**	.27
	EPDS T3			1	.20	.28	.55**
	EPDS T1				1	.77**	.30
	<i>Fathers</i> EPDS T2					1	.33
	EPDS T3						1
VLWB	EPDS T1	1	.67**	.61**	.36**	.33*	.36**
	<i>Mothers</i> EPDS T2		1	.84**	.05	.39**	.39**
	EPDS T3			1	.17	.44**	.44**
	<i>Fathers</i> EPDS T1				1	.08	.57**
	EPDS T2					1	.47**
	EPDS T3						1
FT	EPDS T1	1	.56**	.46**	.33**	.25*	.12
	<i>Mothers</i> EPDS T2		1	.61**	.18	.37**	.28*
	EPDS T3			1	.18	.29**	.31**
	<i>Fathers</i> EPDS T1				1	.60**	.67**
	EPDS T2					1	.73**
	EPDS T3						1

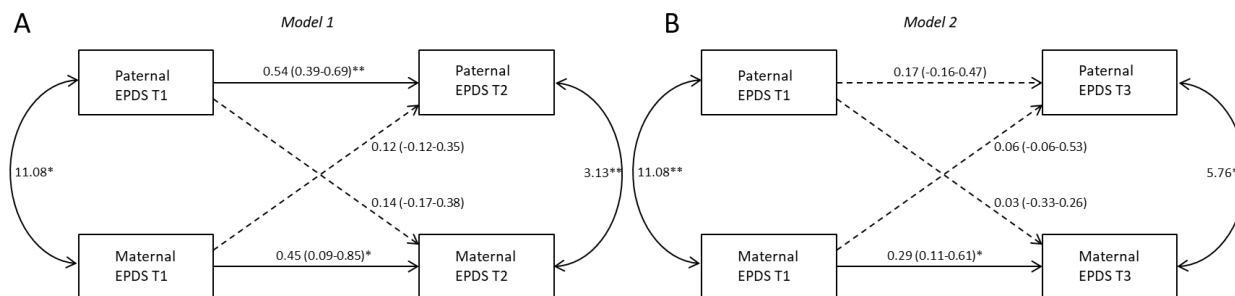
687 * p≤.05

688 **p≤.01

689

Reciprocal influence of PND in preterm mothers and fathers

690 Figure 1: Actor-partner interdependence models for depression in ELBW group.



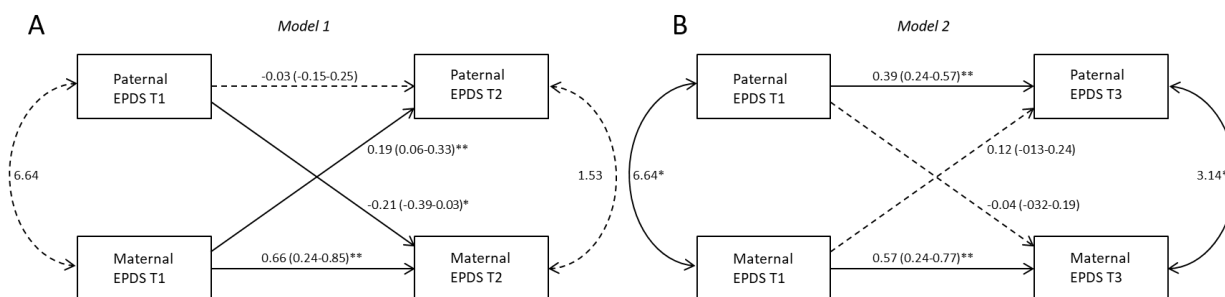
691

692 95% CI are reported in parentheses; * $p \leq .05$; ** $p \leq .01$.

693 *Note.* (A) Model 1: T1D->T2D, (B) Model 2: T1D->T3D. Black lines represent significant paths,
694 dashed lines represent non-significant paths.

695

696 Figure 2: Actor-partner interdependence models for depression in VLBW group



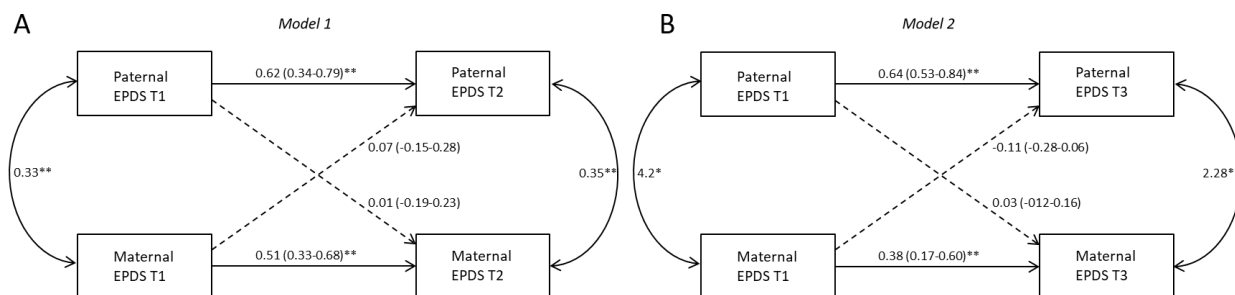
697

698 95% CI are reported in parentheses; * $p \leq .05$; ** $p \leq .01$.

699 *Note.* (A) Model 1: T1D->T2D, (B) Model 2: T1D->T3D. Black lines represent significant paths,
700 dashed lines represent non-significant paths.

701

702 Figure 3: Actor-partner interdependence models for depression in FT group



704

705 95% CI are reported in parentheses; * $p \leq .05$; ** $p \leq .01$.

Reciprocal influence of PND in preterm mothers and fathers

706 *Note.* (A) Model 1: T1D->T2D, (B) Model 2: T1D->T3D. Black lines represent significant paths,
707 dashed lines represent non-significant paths.