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Aurelie Nakamura, Anne-Laure Sutter-Dallay, Fabienne El-Khoury Lesueur, Xavier Thierry, Florence Gressier, Maria Melchior, Judith van Der Waerden

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Informal and formal social support during pregnancy and joint maternal and paternal postnatal depression. Data from the French representative ELFE cohort study

Aurélie Nakamura[1,2,*], Anne-Laure Sutter-Dallay[3,4], Fabienne El-Khoury Lesueur[1], Xavier Thierry[5], Florence Gressier[6,7], Maria Melchior[1,8], Judith van der Waerden[1]

1 Sorbonne Université, INSERM, Pierre Louis Institute of Epidemiology and Public Health (IPLESP), Department of Social Epidemiology, F75012 Paris, France

2 French School of Public Health (EHESP), Doctoral Network, Rennes, France

3 INSERM, UMR 1219, Bordeaux Population Health, Bordeaux University, Bordeaux, France

4 University Department of Adult Psychiatry, Charles-Perrens Hospital, 33000, Bordeaux, France

5 UMS Elfe Team, Institut National d'Etudes Démographiques (INED), F75000 Paris, France

6 CESP, INSERM UMR-1178, Univ. Paris Sud, Le Kremlin Bicêtre, F-94275, France;

7 Department of psychiatry, Assistance Publique-Hôpitaux de Paris, Bicêtre University Hospital, Le Kremlin Bicêtre, F-94275, France

8 French collaborative Institute on Migration (ICM), Paris, France

***Corresponding author:**

Aurélie Nakamura

Sorbonne Université, INSERM, Pierre Louis Institute of Epidemiology and Public Health (IPLESP)

Department of Social Epidemiology

27 rue de Chaligny 75012 Paris, France

aurelie.nakamura@iplesp.upmc.fr

+33681817496

ORCID 0000-0002-2843-3364

Abstract

Background Insufficient social support has been intensively studied as a risk factor of postpartum depression (PPD) among mothers. However, to date no study has examined the role of informal and formal dimensions of social support during pregnancy with regard to joint maternal and paternal depression after birth.

Aim Study associations between insufficient informal and formal support during pregnancy and joint parental PPD.

Methods Using data from the nationally representative French ELFE cohort study (N=12,350), we estimated associations between insufficient informal and formal support received by the mother during pregnancy and joint parental PPD in multi-imputed multivariate multinomial regression models.

Results In 166 couples (1.3%) both parents were depressed. The likelihood of joint parental PPD was increased in case of insufficient informal support (insufficient partner support: OR = 1.68 [95% CI 1.57-1.80]; frequent quarrels: OR = 1.38 [95% CI 1.19-1.60]). We also observed associations between formal support during pregnancy and joint parental PPD (early prenatal psychosocial risk assessment: OR = 1.13 [95%Ci 1.05-1.22]; antenatal education: OR = 1.13 [95% CI 1.05-1.23]), which disappeared when analyses were restricted to women with no psychological difficulties during pregnancy.

Conclusion Insufficient informal social support during pregnancy appears to predict risk of joint postpartum depression in mothers and fathers and should be identified early on to limit complications and the impact on children.

Keywords postpartum depression, mental health, social support, pregnancy, mother-child cohort study, epidemiology

Introduction

Postpartum depression (PPD) is estimated to affect 5 to 25% of mothers (Gaynes et al., 2005) and 8 to 10% of fathers in high-income countries (Cameron et al., 2016; Paulson & Bazemore, 2010). Consequences of maternal and paternal PPD can be severe for the parents themselves, for their relationship with their partner (Ramchandani et al., 2011) and for their children (Kerstis et al., 2014). Parental PPD may impact early parent-child interactions through poor communication and stimulation (Murray et al., 2018) and may subsequently impair the child's cognitive (Ramchandani et al., 2005; Van der Waerden et al., 2015), emotional and behavioral development, especially if depression becomes chronic (Van der Waerden et al., 2015). Every year, a significant proportion of PPD goes undiagnosed or untreated because of parents' lack of knowledge about mental illness and effective treatment strategies, or because of stigma associated with mental health problems during the perinatal period. Costs related to untreated or undiagnosed depression include work-related consequences (e.g. loss of work days, decreased productivity), increased health care use, or deterioration of quality of life (Bauer et al., 2016).

Most previous studies focused either on maternal PPD or paternal PPD separately. Yet, mental health difficulties in both parents can take an especially severe toll on the family and children. Families in which both the mother and father have PPD are often characterized by impaired bonding with the offspring (Kerstis et al., 2016). When one parent is depressed, their partner can buffer the consequences on the family. This is not possible when both parents are depressed, leading to higher levels of parenting difficulties and children's anxiety, depression, conduct disorder or later substance use (Johnson et al., 2008).

One of the major risk factors of maternal and paternal PPD is insufficient social support during pregnancy (Edward et al., 2014; O'Hara & McCabe, 2013). It is important to distinguish between perceived and actual social support (that is individuals' satisfaction with their social relations vs. the sum of supportive behaviors received) (Melrose et al., 2015), which appear to be moderately correlated (Haber et al., 2007). Contrary to actual social support, perceived social support has been consistently associated with positive health outcomes (Melrose et al., 2015). Perceived social support can be further divided into either informal or formal. Informal social support can include support and the quality of relations with the partner (Leung et al., 2017; Massoudi et al., 2016). Formal support in the perinatal

period come from various health professionals, including physicians, midwives, health visitors or mental health professionals. Formal support offered by midwives may include information on how to prepare for parenthood, as well as referral to mental health services if necessary. Antenatal education sessions are often collective, allowing parents to receive both formal support from a midwife and informal support from other parents (Haute Autorité de Santé, 2006). In France, expectant couples are also offered early in pregnancy a prenatal psychosocial risk assessment with a trained midwife during which they can discuss their anticipated physical and psychological health, history of domestic violence and adverse events and the social environment. This assessment is longer than most antenatal education sessions (45-60 minutes) and is in principle offered to all expectant parents (Isserlis et al., 2008).

To our knowledge, only one previous study (Leung et al., 2017) has examined the role of social support as a risk factor for PPD in both parents at the same time. With an estimated prevalence of joint parental PPD of 2.3%, the authors found that key risk factors were family income and maternal PPD, while sufficient prenatal paternal social support appeared to be a protective factor. Paulson et al. (Paulson et al., 2006) and Johansson et al. (Johansson et al., 2017) also reported an association between parental relationship problems and PPD in mothers and fathers, but these studies did not quantify this association with regard to joint parental PPD.

While these outcomes suggest that insufficient social support and poor partner relations increase the risk of PPD, to date no published study has examined their relative impact with regard to postpartum depression occurring simultaneously in both parents.

The aim of the present study was to identify whether perceived informal and/or formal social support during pregnancy are associated with joint parental depressive symptoms in the year following the child's birth. Our first hypothesis was that insufficient informal and formal perceived social support during pregnancy were associated with higher odds of joint parental PPD. A second hypothesis was that insufficient informal and formal perceived social support during pregnancy had a greater impact on joint parental PPD than on either maternal or paternal PPD separately.

Methods

Design and participants

This study used data from the ELFE (*Etude Longitudinale Française depuis l'Enfance*) cohort study. The ELFE study is a nationally-representative birth cohort that follows 18,275 children born in France in 2011 (Charles et al., 2019). Children were recruited in 320 maternity wards using random sampling. To be included, singletons or twins had to be born after at least 33 weeks gestation. Mothers had to be >= 18 years of age and not planning to move out of Metropolitan France in the three years following study inclusion. Mothers had to be able to give consent for the study either in French, English, Arab or Turkish. Fathers also gave consent if they were present on days of inclusion, otherwise they were informed about their right to oppose their child's participation. Data were collected at birth via face-to-face interviews conducted by midwives and self-reported questionnaires. Information on both parents was collected from mothers and fathers via separate phone interviews when the child was two months, one year and two years old. The ELFE study received the approval of France's bodies regulating ethical research conduct (Comité Consultatif sur le Traitement des Informations pour la Recherche en Santé: CCTIRS; Commission National Informatique et Libertés: CNIL).

Measures

Postpartum depression

Depressive symptoms were measured both in mothers and fathers at two months postpartum with the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987). According to previously published cut-offs, scores were dichotomized with a validated cut-off score of ≥ 12 for mothers (Guedeney & Fermanian, 1998) and ≥ 10 for fathers (Edmondson et al., 2010). For the purpose of our analyses, parental depression status was defined as: 1) neither parent depressed, 2) both parents, 3) mother only, 4) father only.

Social support during pregnancy

Informal support during pregnancy was assessed by asking mothers:

1) "During your pregnancy, did you feel very /somewhat/insufficiently /very insufficiently supported by your spouse?" Insufficient partner support was defined as insufficient or very insufficient support from the partner.

2) "During your pregnancy, did you never/rarely/sometimes/often quarrel with your spouse about daily life, friends, children, work?" Frequent quarrels during pregnancy was defined as often quarreling with the partner.

Formal support during pregnancy could be offered by midwives or healthcare professionals through:

1) Early prenatal psychosocial risk assessment (yes; no)
2) Antenatal education (at least one session: yes; no)

Covariates

Demographic characteristics included maternal and paternal age (continuous), maternal and paternal migrant status (native born to French parents; French with at least one migrant parent; migrant) (El-Khoury et al., 2018), parental homogamy (parents of different nationality: yes; no), marital status (married, in a civil union, other) and number of children besides the ELFE child (0; 1; 2 or more). Socioeconomic status was ascertained by the highest level of education attained by both parents (< high school diploma; high school diploma; up to two-year university degree; > two-year university degree), maternal employment during pregnancy (yes; no), paternal employment (yes; no) and financial difficulties (yes; no). We also considered *perinatal health* characteristics such as timing of pregnancy (desired: yes; no), prior history of postpartum depression (yes; no), psychological difficulties during the present pregnancy (yes; no), access to a mental health professional during pregnancy (yes; no), body mass index (<18.5; ≥18.5 and <25; ≥25 and <30; ≥30 kg/m^2) ascertained prior to pregnancy in women and at birth in men; women's gestational weight gain (in kg/m^2) and physical inactivity during the third trimester of pregnancy (based on the Pregnancy Physical Activity Questionnaire, PPAQ (Chandonnet, 2012): yes; no). Pregnancy complications, ascertained in women's medical records, were defined as at least one of the following: threat of premature delivery, membrane rupture, hemorrhage during the second or third trimester, high blood pressure, gestational diabetes, suspicion of a fetal weight anomaly or antenatal administration of corticosteroids for fetal maturation (yes; no). Moreover, C-section birth was also ascertained (yes; no). Finally, tobacco smoking was assessed during pregnancy in mothers, and at two months after the child's birth in fathers. *Offspring-related variables* included sex (male; female), twin birth (yes; no); breastfeeding at

birth (exclusive; non-exclusive; no), hospitalization since birth (yes; no), low birth weight for gestational age and sex (yes; no).

Statistical analyses

We aimed to examine associations between informal and formal social support during pregnancy and joint parental PPD. Our study population included only one child in each pair of twins (n=287) and couples in which both parents answered the second ELFE wave questionnaire (2 months after child's birth, N=14,163). Couples in which either the mother's or the father's EPDS score at 2 months was missing were excluded (n=1,777), leaving a sample of 12,386 families (**Figure 1**). Associations between informal and formal support during pregnancy and joint PPD were ascertained using a multivariate multinomial regression model adjusted for all covariates and study wave and weighted to be representative of the general population of France. Weights were estimated based on sampling (randomized maternity and days), probability of not responding for maternities and families and maternal sociodemographic characteristics (maternal age at birth, region of residence, migrant status, marital status, parity and educational attainment). (Thierry et al., 2018) Parents who were not included due to missing depression score or loss to follow-up were significantly younger (average age 29.7 (sd=5.7) vs. 30.8 (sd=4.8) for mothers and 33.0 (sd=7.1) vs. 33.4 (sd=5.8) for fathers), more often migrant (60% vs. 10% for mothers and 89% vs. 9% for fathers), with non homogamous nationalities (16% vs. 8%), less often married (43% vs. 46%), with lower educational attainment (35% vs. 15% of mothers had a degree lower than high school and 45% vs. 27% for fathers), more often unemployed (39% vs. 17% for mothers and 15% vs. 6% for fathers) and more likely to have financial difficulties (54% vs. 45%) (**Supplemental Table 1**).

Our main research question pertains to social support in relation to joint parental depression. Due to a high proportion of individuals with missing information on key exposure variables or covariates (n=4,086, 33% of the couples with complete EPDS data), multiple imputation models were implemented using the fully conditional specification approach (Van Buuren et al., 2006). Postpartum depression status and weights were not imputed, yielding a sample of 12,386 couples. Supplementary analyses were stratified on the presence of psychological difficulties during pregnancy, which could influence the quality of social relations and access to formal social support during pregnancy.

All analyses were conducted using SAS 9.4. (SAS Inst Cary NC. 2003).

Results

ELFE cohort study participants' characteristics

Among the 12,386 couples with complete EPDS data, 10,278 (83%) were not depressed; in 167 (1.3%) both parents were depressed; in 1,238 (10.0%) only the mother was depressed and in 703 (5.7%) only the father was depressed (**Table 1**).

In comparison with non-depressed couples, couples in which both parents were depressed were more often migrant (22% vs. 7%), had at least one other child (60% vs. 52%), were less educated (30% of mothers and 22% of fathers had at least a bachelor's degree vs. respectively 42% and 35%) and were more likely to have financial difficulties (72% vs. 40%). Depressed couples were less likely to have desired the pregnancy under study (61% vs. 78%) and mothers were more likely to have a prior history of postpartum depression (13% vs. 5%) and psychological difficulties during pregnancy (29% vs. 10%) (**Table 1**).

In comparison with non-depressed couples, during pregnancy, depressed couples were more likely to report insufficient partner support (28% vs. 7%), frequent quarrels (14% vs. 4%), to have seen a mental health professional (9% vs. 3%), and less likely to have attended a prenatal psychosocial risk assessment session (67% vs. 64%) or antenatal education (47% vs. 36%) (**Table 1**).

Informal support from the partner during pregnancy and joint parental PPD

Lack of informal support was associated with a significant increase in joint parental PPD symptoms, even after adjustment for potential covariates. Insufficient support (OR = 1.68 [95% CI 1.57-1.80]) as well as frequent quarrels during pregnancy (OR = 1.38 [95% CI 1.19-1.60]) predicted the odds of both parents being depressed (**Table 2**). The association between insufficient partner support during pregnancy and joint parental PPD was higher for women with psychological difficulties during pregnancy (OR = 2.46 [95%CI 2.14-2.83]), compared to those with no psychological difficulties (OR = 1.42 [95%CI 1.27-1.58]) (**Table 3**).

Formal support during pregnancy and joint parental PPD

Couples in which the mother attended the psychosocial risk assessment (OR = 1.13 [95%Ci 1.05-1.22]) and antenatal education (OR = 1.13 [95% CI 1.05-1.23]) had higher odds of being depressed (**Table 2**). In stratified analyses, we observed a positive association between psychosocial risk assessment and joint parental PPD only in couples in which women had psychological difficulties during pregnancy (OR = 1.64 [95%CI 1.32-2.03]). The association between antenatal education and joint parental PPD was no longer statistically significant (**Table 3**).

Informal and formal support during pregnancy and maternal or paternal PPD

Insufficient partner support and frequent quarrels during pregnancy were also associated with an increased probability of only maternal PPD and only paternal PPD even after adjustment for potential confounders.

A positive association was observed between access to a psychosocial risk assessment and paternal PPD (OR = 1.14 [95% CI 1.11-1.17]) as well as antenatal education and maternal PPD (OR = 1.09 [95% CI 1.07-1.11]) (**Table 2**).

Discussion

Main results

Using data from a large nationally representative sample, we aimed to identify whether informal and formal social support during pregnancy were associated with symptoms of depression in both parents two months following their child's birth. Insufficient informal support during pregnancy was associated with elevated odds of both parents having postpartum depression. The association between formal support during pregnancy and joint parental PPD was less clear: couples who benefited from psychosocial risk assessment or antenatal education had an increased probability of joint PPD, particularly in the presence of preexisting maternal psychological difficulties.

Comparison with past studies

The prevalence of joint parental PPD (1.3%) in our study was comparable with that observed by Massoudi et al. (Massoudi et al., 2016) (1.5%, 2016, Sweden) and Leung et al (Leung et al., 2017) (2.3%, 2017, Canada), but lower than in Paulson et al's study (Paulson et al., 2006)(2.9%, 2006, the United Kingdom). The study conducted by Leung et al (Leung et al.,

2017) also showed that a lack of paternal support during pregnancy was associated with joint parental PPD. Paulson et al. (Paulson et al., 2006) and Johansson et al. (Johansson et al., 2017) additionally reported an association between relationship problems and maternal and paternal PPD, but these studies did not quantify this association with regard to joint parental PPD.

Informal social support during pregnancy

To our knowledge, this is the first study to evaluate the association between informal and formal support during pregnancy and joint parental PPD.

Many studies have observed that a lack of social support is one of the main risk factors of PPD in women (O'Hara & McCabe, 2013; Robertson et al., 2004). Unsatisfactory couple relationships have also been reported as a risk factor, both in mothers and fathers (Matthey et al., 2000; Robertson et al., 2004). Our study extends existing evidence by showing that a lack of informal social support from the father contributes to the increased likelihood of joint parental PPD. Fathers who are not able to sufficiently support their partner during pregnancy may equally experience difficulties finding their place in their new family. In addition of being less able to help their partner to cope with difficulties after child birth, they may experience lower self-esteem insufficient parenting skills, which increases their risk of experiencing depression themselves. (Glangeau-Freudenthal, 2017)

Formal support during pregnancy

In our study, less than 40% of women reported attending a prenatal psychosocial risk assessment, which is far below official recommendations (Barandon et al., 2016) Surprisingly, we found an inverse association between psychosocial risk assessment attendance and joint parental PPD, especially in couples in which the mother had psychological difficulties during pregnancy. Fathers are not systematically invited to attend the psychosocial risk assessment, giving women the opportunity to discuss vulnerabilities such as domestic violence or adverse events that could affect their pregnancy.

Approximately 60% of women attended antenatal education. A recent systematic review on interventions aiming to prevent PPD underlined women's reluctance to attend antenatal education, because of embarrassment associated with sharing private information. Low participation could also be explained by the lack of homogeneity in

recommendations made by health professionals (e.g. How many sessions? Should fathers be invited as well?) (Morrell et al., 2016). We found that attendance of antenatal education was higher in women who had seen a mental health professional during pregnancy (72 vs. 63% in other women), suggesting that benefiting from support from a mental health professional could increase support from other health professionals. When stratifying our analyses on psychological difficulties during pregnancy, the association between antenatal education and joint parental PPD lost statistical significance especially in women with difficulties during pregnancy. Thus antenatal education, though support from other participants and health professional, could be more effective against PPD for women with psychological difficulties during pregnancy.

We had no data on father's attendance of antenatal education, but it was probably lower than in women, especially for multiparous fathers (Redshaw & Henderson, 2013). On the other hand, Greenhalgh et al. (Greenhalgh et al., 2000) noted that a key reason why men avoid child birth preparation classes is anxiety. Other reasons include men feeling uncomfortable and receiving mixed messages about their role from midwives. In a qualitative study, men stated that birth classes were not their first source of information and that they were not sufficiently focused on fathers' roles. They reported feeling the need to talk to other fathers, without the presence of their spouse. Finally, fathers perceived antenatal education to be directed to women and felt treated as "the second parent". (Premberg & Lundgren, 2006) . It important to note that paternal participation to antenatal education can be beneficial for their spouses. One randomized controlled trial found that in couples attending antenatal education, women had lower levels of PPD, especially because fathers were better prepared for the transition to parenthood and could provide better support to their spouses (Matthey et al., 2004).

However, more generally speaking, research on this topic is mostly focused on father's support to women but not their own mental health. To our knowledge, only one intervention focused on preventing paternal PPD using prenatal support through an educational program, leading to positive results (Charandabi et al., 2017).

Limitations and strengths

Our study has several limitations which should be noted. First, PPD in fathers was assessed using the EPDS. Although this scale has been validated, recent studies underline that it may not be the best tool to evaluate depression in men. They tend to express depression via externalizing symptoms (such as anger and substance abuse for example) which are not assessed by the EPDS. Using a complementary scale which covers additional symptoms might give a better indication of paternal PPD (Massoudi et al., 2013). (Psouni et al., 2017) Moreover, postpartum depression was measured once, two months after the child's birth, while there is evidence that highest rates of paternal PPD are generally observed between 3-6 months after the child's birth. (Cameron et al., 2016; Paulson & Bazemore, 2010)

Second, we lacked information on maternal and paternal psychiatric history and comorbidities. For example, maternal depression outside of prior pregnancies and paternal history of depression was not recorded. We observed an association between insufficient social support and frequent quarrels during pregnancy and joint parental PPD but insufficient social support and frequent quarrels could also result from parental depression prior to pregnancy. Similarly, we had no information on other comorbidities such as sleep disorders after the child's birth. Additionally, adverse life events in the year preceding pregnancy were not ascertained. Third, only mothers were asked about social support during pregnancy, therefore we could not study the father's perception of lack of social support with regard to joint parental PPD. Fourth, only perceived informal social support was studied. No information regarding received informal social support was provided. Informal social support was assessed only regarding partner support. Support from other family members or friends was not ascertained. Additionally, attendance of the psychosocial risk assessment and antenatal education was self-reported, possibly leading to inaccurate reporting. Finally, more than 4,000 couples had missing data on PPD. Couples that were not included in our study had lower socioeconomic position and might have been in worse health. Thus, we cannot exclude that we underestimated the prevalence of joint parental PPD.

Our study also has important strengths. We studied a large sample of 12,000 couples drawn from the general population and had information about both maternal and paternal depression, which is seldom jointly collected. Additionally, we controlled for multiple

characteristics potentially associated with social support and parental depression and identified factors specifically associated with joint parental PPD.

Implications for practice

Our first recommendation would be to encourage support for positive family and spousal relationships so that each member of the family finds his/her place during the transition to parenthood. Social support, as well as depression screening, from the beginning of pregnancy, seem to be important to prevent PPD in both mothers and fathers, especially since support tends to decrease across pregnancy. (Simpson et al., 2003) According to an extensive systematic review of quantitative and qualitative studies (Morrell et al., 2016), the most effective interventions for reducing PPD are conducted by midwives, at 3 and 12 months after the child's birth. To our knowledge, no intervention study has explored the efficacy of offering formal support to both parents to prevent joint parental PPD. Second, promoting couple relationships during pregnancy could reduce PPD both in mothers and fathers (Shapiro & Gottman, 2005). A study, led by clinical psychologists, was based on strengthening the couple's relations and involvement in the family, and giving them information on parenthood. Parents both benefited from a long-term reduction in depressive symptoms throughout the first year after birth. When including fathers in psychosocial risk assessment, antenatal education or other intervention, it is important to adapt sessions to mothers' and fathers' specific needs.

Conclusion

In the last decades, men have become increasingly involved both in pregnancy and childcare. There is also evidence that a non-negligible number suffers from postnatal depression. However, prevention of postpartum depression remains mainly directed towards women. Our study suggests that insufficient social support during pregnancy could contribute to elevated levels of depression in new fathers, suggesting that prevention policies should be directed at both parents.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Author's contributions

MM, JW and AN developed the initial idea for the study and drafted the manuscript; AN performed the statistical analyses. All authors contributed to interpreting the results, as well as read, revised and approved the final manuscript.

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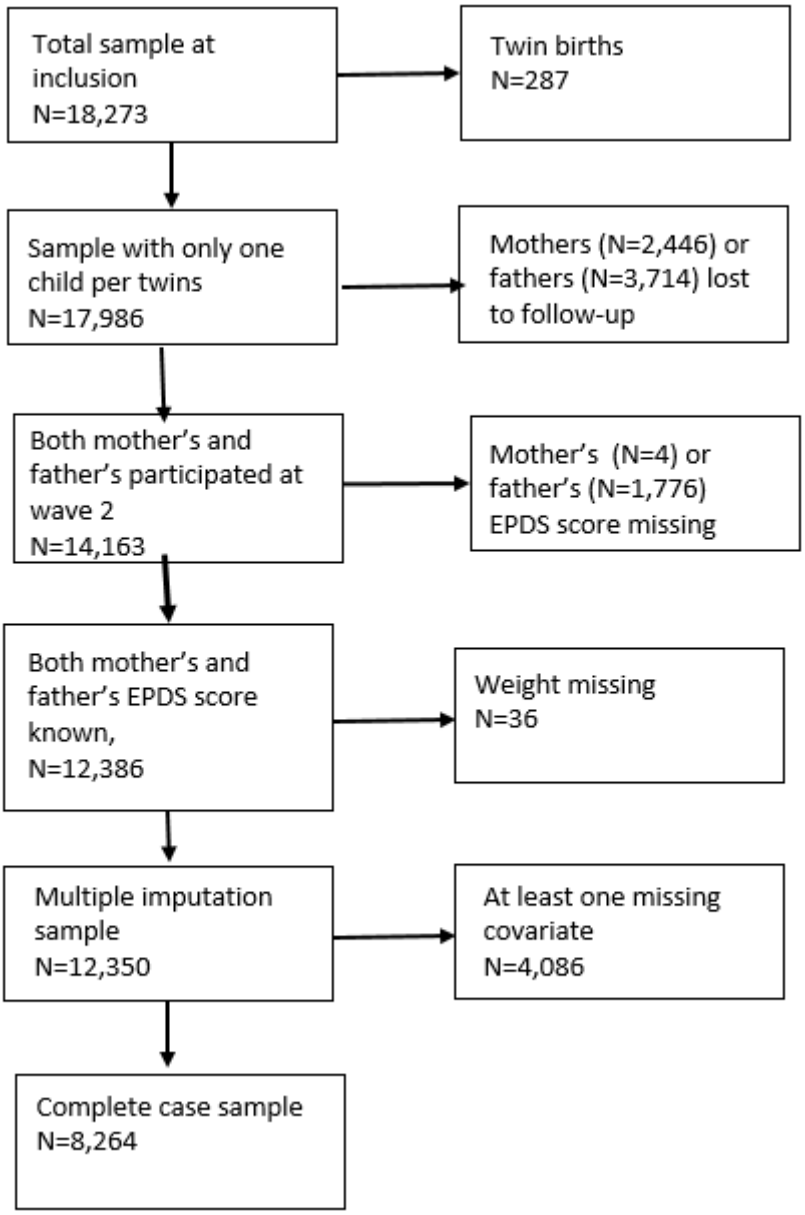

Figure 1 – Flowchart describing sample selection, ELFE cohort study 2011-2013

Table 1 – Characteristics of study participants and parental postpartum depression (N and % or means and standard deviation calculated on multi-imputed data), ELFE cohort study 2011-2013, n=12,386

	None	**Both**	**Only mother**	**Only father**
N = 12,386	N = 10,278	N = 167	N = 1,238	N = 703
Demographic characteristics	N (%) / mean (sd)	N (%) / mean (sd)	N (%) / mean (sd)	N (%) / mean (sd)
Mother's age	30.9 (4.7)	30.8 (4.7)	31.3 (5.0)	31.0 (4.9)
Father's age	33.3 (5.7)	34.0 (5.8)	33.6 (6.0)	34.5 (6.5)
Mother's migrant status				
French born to French parents	8,513 (82.8)	111 (66.5)	935 (75.5)	515 (73.3)
French descending from at least one migrant parent	1,092 (10.6)	25 (15.0)	124 (10.0)	92 (13.1)
Migrant	673 (6.6)	31 (18.5)	179 (14.5)	96 (13.6)
Father's migrant status				
French born to French parents	8,493 (82.6)	111(66.5)	962 (77.6)	484 (68.8)
French descending from at least one migrant parent	1,064 (10.4)	19 (11.4)	138 (11.2)	85 (12.1)
Migrant	721 (7.0)	37 (22.1)	138 (11.2)	134 (19.1)
Mixed couple (yes)	578 (5.6)	20 (11.9)	117 (9.4)	95 (13.5)
Marital status				
Married	4,932 (48.0)	81 (48.6)	579 (46.8)	337 (48.0)
In civil union	1,844 (17.9)	25 (15.2)	220 (17.8)	92 (13.1)
Other	3,502 (34.1)	61 (36.2)	439 (35.4)	274 (38.9)
Parity				
0	4,925 (47.9)	66 (39.5)	528 (42.7)	267 (38.0)
1	3,597 (35.0)	62 (37.0)	485 (39.2)	277 (39.4)
≥ 2	1,756 (17.1)	39 (23.5)	225 (18.2)	159 (22.6)
Mother's highest diploma				
< High school diploma	1,181 (11.5)	30 (18.0)	183 (14.8)	118 (16.8)
High school diploma	1,723 (16.8)	46 (27.5)	245 (19.8)	146 (20.8)
2-year degree	3,028 (29.5)	41 (24.6)	354 (28.6)	183 (26.0)

≥ Bachelor's degree	4346 (42.3)	50 (29.9)	456 (36.8)	256 (36.4)
Father's highest diploma				
< High school diploma	2,679 (26.1)	74 (44.3)	326 (26.4)	249 (35.4)
High school diploma	2,076 (20.2)	33 (19.8)	263 (21.2)	140 (20.0)
2-year degree	1,934 (18.8)	23 (13.8)	224 (18.1)	112 (16.0)
≥ Bachelor's degree	3,589 (34.9)	37 (22.2)	425 (34.3)	202 (28.7)
Mother's employment during pregnancy (yes)	8,887 (86.5)	114 (68.3)	1,002 (80.9)	564 (80.3)
Father's employment (yes)	9,756 (94.9)	154 (92.0)	1,146 (92.6)	621 (86.4)
Financial difficulties (yes)	4,105 (39.9)	121 (72.5)	652 (52.6)	353 (50.2)
Perceived social support during pregnancy				
Informal support				
Insufficient partner support (yes)	720 (7.0)	46 (27.8)	195 (15.8)	100 (14.3)
Frequent quarrels (yes)	383 (3.7)	25 (15.0)	123 (9.9)	53 (7.6)
Formal support				
Psychosocial risk assessment (yes)	3,674 (35.9)	56 (33.4)	443 (35.8)	259 (36.8)
Antenatal education (yes)	6,546 (63.7)	88 (52.2)	764 (61.7)	391 (55.6)
Health & Perinatal health				
Planned pregnancy (yes)	8,039 (78.2)	102 (61.1)	881 (71.2)	516 (73.4)
Previous postpartum depression (yes)	555 (5.4)	22 (13.1)	152 (12.3)	63 (8.9)
Psychological difficulties during pregnancy (yes)	1,030 (10.0)	49 (29.4)	304 (24.6)	91 (13.0)
Access to a mental health professional (yes)	276 (2.3)	16 (9.5)	122 (9.8)	22 (3.1)
Physical inactivity during pregnancy (yes)	4,855 (47.2)	76 (45.2)	564 (45.6)	358 (51.0)
Gestational weight gain (kg)	13.2 (5.4)	13.3 (6.0)	13.2 (5.2)	12.9 (6.0)
Complication during pregnancy (≥1)	2,982 (29.0)	54 (32.5)	380 (30.7)	217 (30.9)
C-section (yes)	1,819 (17.7)	33 (19.5)	231 (18.7)	133 (19.0)
BMI before pregnancy (kg/m2)				
BMI < 18.5 kg/m2	749 (7.3)	11 (6.3)	93 (7.5)	37 (5.3)
18.5 ≤ BMI < 25 kg/m2	6,964 (67.8)	99 (59.6)	803 (64.9)	444 (63.1)
25 ≤ BMI < 30 kg/m2	1,662 (16.2)	35 (21.1)	225 (18.2)	139 (19.7)

BMI ≥ 30kg/m2	903 (8.8)	22 (13.0)	117 (9.5)	83 (11.8)
Father's BMI (kg/m2)				
BMI < 18,5 kg/m2	76 (0.7)	2 (1.3)	6 (0.5)	8 (1.1)
18.5 ≤ BMI < 25 kg/m2	5,697 (55.4)	87 (52.3)	659 (53.3)	383 (54.7)
25 ≤ BMI < 30 kg/m2	3,678 (35.8)	62 (37.4)	477 (38.5)	253 (35.9)
BMI ≥ 30kg/m2	827 (8.0)	15 (9.0)	95 (7.7)	58 (8.3)
Maternal smoking during pregnancy (yes)	1,821 (17.7)	41 (24.8)	234 (18.9)	137 (19.4)
Paternal smoking at 2 months postpartum (yes)	3,556 (34.6)	74 (44.3)	456 (36.8)	277 (39.4)
Offspring				
Twin birth (yes)	157 (1.5)	2 (1.2)	25 (2.0)	15 (2.1)
Sex (girl)	5,102 (49.6)	80 (47.9)	546 (44.1)	342 (48.7)
Small birth weight for gestational age (yes)	847 (8.2)	14 (8.4)	94 (7.6)	48 (6.8)
Breastfeeding at the maternity ward				
Exclusive	6,634 (64.8)	114 (68.1)	813 (65.7)	486 (69.2)
Non exclusive	934 (9.1)	16 (9.6)	131 (10.6)	69 (9.8)
No	2,681 (26.1)	37 (22.3)	295 (23.8)	148 (21.0)
Hospitalization since birth (yes)	555 (5.4)	15 (9.0)	104 (8.4)	43 (6.2)

BMI = body mass index

Table 2 –Informal and formal support during pregnancy and joint parental postpartum depression

	Both	**Only mother**	**Only father**
N = 12,350	N = 166	N = 1,230	N = 702
Informal support			
Insufficient partner support (yes)	**1.68 [1.57-1.80]***	1.30 [1.28-1.32]	1.26 [1.23-1.30]
Frequent quarrels (yes)	**1.38 [1.19-1.60]***	1.20 (1.15-1.25]	1.24 [1.17-1.30]
Formal support			
Psychosocial risk assessment (yes)	**1.13 [1.05-1.22]***	1.01 [0.99-1.03]	1.14 [1.11-1.17]
Antenatal education (yes)	**1.13 [1.05-1.23]***	1.09 [1.07-1.11]	0.96 [0.93-1. 01]

Adjusted odds ratios (reference = none parent depressed) and 95% confidence intervals, ELFE cohort study 2011–2013, N = 12,350. *p-value < 0.001.

Adjustment on age, individual migrant status, parents' nationality homogamy, marital status, parity, highest level of education attained, employment during pregnancy, financial difficulties, timing of pregnancy*, prior pregnancy history of postpartum depression*, psychological difficulties during pregnancy*, access to a mental health professional*, body mass index, gestational weight gain*, physical inactivity during the third trimester of pregnancy*, pregnancy complications*,C-section*, tobacco smoking (during pregnancy more mothers, two months after birth for fathers), twin birth, offspring's sex, breastfeeding at birth , offspring's hospitalization since birth and low birth weight for gestational age and sex. *Measured only in mothers

Table 3 –Informal and formal support during pregnancy and joint parental postpartum depression, stratified on psychological difficulties during pregnancy

No psychological difficulties during pregnancy	**Both**	**Only mother**	**Only father**
N = 10,887	N = 118	N = 928	N = 612
Informal support			
Insufficient partner support (yes)	**1.42 [1.27-1.58]***	1.36 [1.34-1.38]	1.26 [1.21-1.30]
Frequent quarrels (yes)	**1.44 [1.24-1.67]***	1.21 (1.15-1.26]	1.32 [1.24-1.41]
Formal support			
Psychosocial risk assessment (yes)	1.00 [0.94-1.06]	0.95 [0.92-0.98]	1.11 [1.07-1.15]
Antenatal education (yes)	1.13 [0.99-1.28]	1.17 [1.14-1.19]	0.96 [0.92-0.99]

Psychological difficulties during pregnancy	**Both**	**Only mother**	**Only father**
N = 1,463	N = 48	N = 302	N = 90
Informal support			
Insufficient partner support (yes)	**2.46 [2.14-2.83]***	1.19 [1.12-1.26]	1.20 [1.19-1.39]
Frequent quarrels (yes)	**1.61 [1.13-2.29]***	1.25 (1.15-1.36]	1.23 [1.10-1.38]
Formal support			
Psychosocial risk assessment (yes)	**1.64 [1.32-2.03]***	1.25 [1.17-1.32]	1.37 [1.28-1.48]
Antenatal education (yes)	1.00 [0.85-1.17]	0.96 [0.93-0.99]	0.93 [0.86-1.01]

Adjusted odds ratios and 95% confidence intervals, ELFE cohort study 2011-2013, N=12,350.
*p-value<0.001

Adjustment on age, individual migrant status, parents' nationality homogamy, marital status, parity, highest level of education attained, employment during pregnancy, financial difficulties, timing of pregnancy*, prior pregnancy history of postpartum depression*, body mass index, gestational weight gain*, physical inactivity during the third trimester of pregnancy*, pregnancy complications*,C-section*, tobacco smoking (during pregnancy more mothers, two months after birth for fathers), twin birth, offspring's sex, breastfeeding at birth , offspring's hospitalization since birth and low birth weight for gestational age and sex.
*Measured only in mothers

Supplementary Table 1 – Social characteristics (N and % or mean and standard deviation) of mothers and fathers, according to the missingness of their PPD status. ELFE cohort study 2011-2013.

	Mothers			Fathers		
	PPD missing	**PPD not missing**	**N**	**PPD missing**	**PPD not missing**	**N**
Social characteristics						
Age	29.7 (sd=5.7)	30.8 (sd=4.9)	N=17,850	33.0 (sd=7.1)	33.4 (sd=5.8)	N=17,076
Migrant status			N=16,471			N=13,878
French born to French parents	307 (28.9)	11,986 (77.8)		109 (7.5)	10,041 (80.8)	
French descending from at least one immigrant parent	119 (11.1)	1,880 (12.2)		55 (3.8)	1,317 (10.6)	
Immigrant	638 (60.0)	1,541 (10.0)		1,282 (88.7)	1,074 (8.6)	
Parents' nationality homogamy (no)	364 (16.2)	1,228 (8.2)	N=17,267	768 (15.3)	824 (6.7)	N=17,267
Marital status			N=17,506			N=17,506
Married	990 (42.6)	7,056 (46.5)		2,160 (40.7)	5,886 (48.2)	
Civil partners	182 (7.8)	2,391 (15.8)		436 (8.2)	2,137 (17.5)	
Other	1,150 (49.5)	5,737 (37.8)		2,706 (51.0)	4,181 (34.3)	
Highest diploma			N=17,930			N=12,678
< High school diploma	834 (34.8)	2,351 (15.1)		90 (45.5)	3,371 (27.0)	
High school diploma	685 (28.6)	2,978 (19.2)		44 (22.2)	2,534 (20.3)	
2-year degree	788 (32.9)	4,397 (28.3)		29 (14.7)	2,303 (18.5)	
Bachelor's degree	87 (3.6)	5,810 (37.4)		35 (17.7)	4,272 (34.2)	
Employment (no)	881 (39.1)	2,619 (17.3)	N=17,427	731 (14.7)	722 (5.6)	N=17,348
Financial difficulties (yes)	188 (54.2)	6,953 (44.8)	N=15,871	1,913 (54.8)	5,228 (42.2)	N=15,871