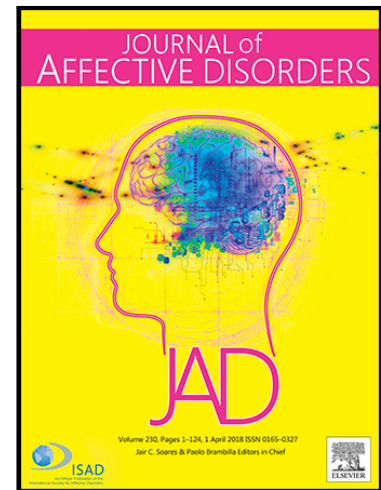


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Prevalence of postpartum depressive symptoms in a multiethnic population and the role of ethnicity and integration

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**HIGHLIGHTS**

- A prevalence rate of postpartum depressive symptoms of 9.3% for the whole study sample; 4.8% for Western European women and 12.7% for the ethnic minorities.
- The prevalence was highest in Middle Eastern and South Asian women.
- In contrast to minority women, majority of the Western European women with postpartum depressive symptoms also had depressive symptoms during pregnancy.
- Ethnic minority background was independent risk factor for postpartum depressive symptoms, in addition, recent adverse life events, lack of social support and depressive symptoms in the index pregnancy were explored, which were also significant risk factors for postpartum depressive symptoms.
- Low social integration was an independent risk factor for postpartum depressive symptoms when replacing ethnicity in our models.

**Title****Prevalence of postpartum depressive symptoms in a multiethnic population and the role of ethnicity and integration**

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**Background:** Postpartum depression (PPD) may have adverse effects on both mother and child. The aims were to determine the prevalence of postpartum depressive symptoms, PPDS, identify associations with ethnicity and with the level of social integration.

**Method:** Population-based, prospective cohort study of 643 pregnant women (58 % ethnic minorities) attending primary antenatal care in Oslo. Questionnaires regarding demographics and health issues were collected through interviews. PPDS was defined as a sum score  $\geq 10$  by the Edinburgh Postnatal Depression Scale, used as the main outcome in logistic regression analyses, first with ethnicity, second with level of integration as main explanatory factors.

**Results:** The prevalence of PPDS was higher in ethnic minorities 12.7% (95 % CI: 9.31-16.09) than in Western Europeans 4.8 % (2.26-7.34). Adverse life events, lack of social support and depressive symptoms during the index pregnancy were other significant risk factors. Western European with PPDS were more likely to have had depressive symptoms also during pregnancy than women from ethnic minorities (72.2% versus 33.3 %,  $p=0.041$ ). When replacing ethnicity with integration, a low level of integration was independently associated with PPDS (2.1 (1.11-3.95)).

**Limitations:** Cases with PPDS were limited. Heterogeneity in the ethnic groups is a concern.

**Conclusion:** Both point prevalence and new onset of PPDS was higher among ethnic minorities than among Western Europeans. Low level of integration was associated with PPDS. Our findings suggest that clinicians should be aware of the increased risk of new cases of PPDS among ethnic minorities compared to Western European women and offer evidence-based care accordingly.

## Abbreviations

PPD: Postpartum depression; PPDS: Postpartum depressive symptoms GW: Gestational week; SD: Standard deviation; EPDS: Edinburgh Postnatal Depression Scale; IQR: Interquartile range; SEP: Socioeconomic position; PCA: Principal component analysis; OR: Odds ratio

## **Key words**

**Postpartum depression, postpartum depressive symptoms, prevalence, risk factors, ethnic groups, immigrants, integration, perinatal mental health**

## **Introduction**

Postpartum depression (PPD) is prevalent, as most studies report rates of 10-15%, but estimates differ considerably, from 3% to more than 25% depending on the population, context and instruments and strategies used to identify cases (Dennis and Dowswell, 2013; Dennis and Hodnett, 2007; Melo et al., 2012). PPD may be a continuation of symptoms experienced during pregnancy or a new onset of depression. Not only the mother's health but also the relationship with her partner and any other children may be affected. In addition, PPD can lead to poor attachment between the newborn and the mother, which may interrupt breastfeeding (Silva et al., 2017) and negatively affect the cognitive and emotional development of the infant (Grace et al., 2003). Further, maternal PPD has been associated with the development of intellectual problems, social dysregulation, violent behavior and psychiatric problems in the child (Hay et al., 2003; Hay et al., 2001; Murray et al., 2011; Pawlby et al., 2008).

Known risk factors for PPD are previous depression, adverse life events and lack of social support (Norhayati et al., 2015). In addition, many studies have also found that low socioeconomic position (SEP) may increase the risk (Norhayati et al., 2015). Of note is that

in some patriarchal societies, it may be considered more preferable to give birth to a boy (Husain et al., 2012; Wittkowski et al., 2016), posing a potential risk of higher PPD rates for mothers with daughters, but findings are contradictory (Husain et al., 2012; Norhayati et al., 2015; Wittkowski et al., 2016). In studies from Western countries, immigrant women may experience higher rates of PPD or postpartum depressive symptoms, PPDS, compared with native Western Europeans, partly due to language problems and poor social integration (Falah-Hassani et al., 2015; Norhayati et al., 2015). More specifically, the harmful effects of perceived prejudice and discrimination experienced by immigrants, referred to as “minority stress”, are observed across a range of mental health outcomes including depression (Pascoe and Smart Richman, 2009). Importantly, we have little empirical knowledge about the impact of cultural differences and the level of integration on PPD or PPDS (Fung and Dennis, 2010). Migration and acculturation may be stressful and can induce mental health problems, and some studies found that a low level of integration was associated with depression or depressive symptoms, although in a complex manner (Bhugra and Becker, 2005; Gonidakis et al., 2011; Unlu Ince et al., 2014). Moreover, there may be synergistic effects of migration, integration and other social factors, such as SEP and family social support, which could make ethnic minority women even more vulnerable to PPDS.

The potentially long-lasting adverse effects on the offspring make PPDS an important public health issue. The immigrant population in Norway is growing, as in rest of Europe. In order to optimize the health care we need more knowledge about specific health challenges among immigrants. Migrant women are more likely to experience postpartum depressive symptoms, PPDS, compared to native-born women, with a prevalence of about 20 % among ethnic minority women (Falah-Hassani et al., 2015). However, there is a lack of population-based studies (Falah-Hassani et al., 2015), and little is known about prevalence rates among a population with limited commands of the majority language and those newly

arrived, as these groups often are excluded from research.

We have earlier reported a double risk of depression in pregnancy among ethnic minority women (Shakeel et al., 2015). To the best of our knowledge, only one previous study from Norway have reported prevalence of PPD among immigrants (Bjerke et al., 2008). Hence, the primary aim of this study was to assess the prevalence of postpartum depressive symptoms (PPDS), and explore its associations with ethnicity. Secondly, we wanted to investigate whether low level of social integration was associated with PPDS.

## **Methods**

### **Design, study population and setting**

This study is part of the STORK Groruddalen Research Program, which is a population-based, prospective cohort of 823 healthy pregnant women attending the Child Health Clinics for antenatal care in Groruddalen, Oslo, Norway, between 2008 and 2010. Antenatal care for normal pregnancies in Norway is carried out in primary health care by either the general practitioner, midwife or both. The STORK Groruddalen project has previously been described in detail (Jenum et al., 2012; Jenum et al., 2010). Briefly, information material and questionnaires were translated into eight different languages and quality checked by bilingual health professionals, and questionnaire data regarding demographics and health related issues were collected through interviews by midwives at three visits: at inclusion (mean gestational week (GW) 15), at a follow-up in GW 28, and 14 weeks postpartum. Professional translators were used when needed. Women were eligible for participation if they: 1) lived in the districts; 2) planned to give birth at one of two study hospitals; 3) were <20 week's GW at inclusion; 4) could communicate in Norwegian, Arabic, English, Sorani, Somali, Tamil, Turkish, Urdu or Vietnamese; and 5) were able to give informed written consent. Women with known diabetes and/or other diseases necessitating intensive hospital

follow-up during pregnancy were excluded, according to protocol. The inclusion rate was 74% (range 64-83% among ethnic groups), and the participating women were found to be representative of all pregnant women attending the Child Health Clinics. Informed consent was obtained from all individual participants included in the study. The study was approved by The Regional Committee for Medical and Health Research Ethics for South Eastern Norway (reference number: 2007.894) and The Norwegian Data Inspectorate.

### **Primary outcome variable – postpartum depressive symptoms**

The Edinburgh Postnatal Depression scale (EPDS), developed to measure depressive symptoms after delivery (Cox, 2003; Harris et al., 1989), is a ten-item self-rating scale with a sum score range of 0-30, with higher scores indicating more symptoms (Cox et al., 1987). We used a cut-off value of  $\geq 10$  as indicative of depressive symptoms, as this cut-off level has been used previously in several epidemiological studies (Dorheim et al., 2012, 2014; Eberhard-Gran et al., 2001b; Hewitt et al., 2009). The EPDS was administered through interviews performed by midwives, who were trained to ensure standardized data collection procedures at the postpartum visit. We used eight official translations of the EPDS (Norwegian, Arabic, English, Somali, Tamil, Turkish, Urdu and Vietnamese). In addition, we used a version in Sorani, translated by the City Services Department's Interpreting Service in Oslo for this study. All except the Somalian and Sorani versions have been validated (Dr Jann Marshall, 2006).

### **Exposure variables**

#### Ethnicity

Ethnicity was our primary variable of interest. Ethnic origin was defined by the country of birth of the pregnant participant. If the participant's mother was born outside of Europe or North America, the country of origin was defined by the participant's mother's country of birth. This was further categorized as Western European and ethnic minority women, the



latter further subdivided into Middle Easterners (mainly from Iraq, Iran and Turkey), South Asians (mainly from Pakistan and Sri Lanka), and others (from Eastern Europe, Africa South of Sahara, East Asia and South and Central America)(Jenum et al., 2010). These categories were chosen as these groups considered to have some shared cultural practices that differ from groups originating from Europe, where for instance more individual-oriented values dominate, versus the more collectivistic and family-oriented values of the traditional Asian and African culture (Eberhard-Gran et al., 2010). In general, few among ethnic minorities were second-generation immigrants (7 %), and of these 75.6% were of Pakistani origin.

#### Level of integration

As an alternative to ethnicity, we also explored factors related to the level of social integration into the Norwegian mainstream society. In accordance with our secondary aim, we used the level of integration as the main exposure factor. Our integration variable holds information from questionnaires about: 1) language skills (need of interpreter - during study interviews, need of interpreter at a doctor's appointment, self-reported abilities in the Norwegian language), 2) time of residence, 3) how often one reads a Norwegian newspaper or watches Norwegian TV, and 4) how often one is visited (in any context) by an ethnic Norwegian. Ethnic Norwegian participants were not asked these questions but were automatically given the highest value for these variables. a component score was extracted using principal components analysis, explained in more details under statistics.

(Shakeel et al., 2015; Sletner et al., 2014).

#### **Other variables**

##### Adverse life events

Seven questions assessed stressful life events: 1) serious illness or injury (self); 2) serious illness or injury of a close family member; 3) death of a close family member; 4) divorce or separation following a long-term relationship; 5) unemployment or serious difficulty finding a job; 6) major concerns about children; and 7) any other major events not already covered, such as serious financial problems, difficulties at work, and serious conflicts. Response options were “yes” or “no”. Women reported adverse life events in GW 28, including events that occurred following their inclusion in the study, and then again in the postpartum visit, including any new events occurring after GW 28. First, the number of events for each time was calculated and then combined in a single variable, to reflect the total number of events from inclusion in the study through the postpartum visit. This variable was recoded as 0-1 (reference), 2 or  $\geq 3$  events.

#### Social support

At the postpartum visit, the women were asked if practical and emotional support and care from those closest to them around the time of their labor and delivery were adequate according to their needs, with three possible response categories: “to a large extent”, “to some extent”, and “to a small extent”. This variable was dichotomized (the first two merged), driven by the distribution of data.

#### Previous history of depression and depressive symptoms in the index pregnancy

Information on history of depression was obtained by Kendler’s lifetime major depression scale, which assesses lifetime history of major depression based on the DSM-IV criteria (Kendler et al., 1993; Kjeldgaard et al., 2017). This scale consists of five questions concerning sadness, appetite changes, lack of energy, self-blame and concentration problems with the response categories “yes” or “no”. Prior depression was defined as having had at

least two simultaneously concurrent symptoms with duration of at least two weeks in addition to sad mood (Kendler et al., 1993; Kjeldgaard et al., 2017). As depressive symptoms in pregnancy are associated with PPDS (Norhayati et al., 2015), we also used the EPDS score from gestational week 28 and categorized women with a score  $\geq 10$  during pregnancy as “depressive symptoms in index pregnancy”.

### Socioeconomic position

We used the following socioeconomic variables: educational level, occupational class, employment status, renting tenure and rooms per person in the household collected at inclusion. a component score (Cronbach's  $\alpha > 0.7$ ) was extracted using principal components analysis, explained in more details under statistics.

### Gestational diabetes

We used information about gestational diabetes according to the WHO 1999 criteria (fasting plasma glucose  $\geq 7.0$  mmol/l and/or 2-hour plasma glucose  $\geq 7.8$  mmol/l) (Alberti and Zimmet, 1998), after having offered all participants an oral glucose tolerance test at GW 28.

### Other variables used for descriptive purposes

Information about marital status/single parenthood, use of interpreter at the first visit, weeks postpartum, parity, education, offspring gender, gestational diabetes and the use of antidepressants were explored and used to describe the sample.

### Study sample

From the total cohort of 823 women included in the STORK Groruddalen study, 662 women attended the postpartum visit and 632 had valid EPDS scores with answers to all 10 questions. For 11 women with 1-3 missing answers (1 missing:  $n=7$ ; 2 missing:  $n=2$ ; and 3

missing:  $n=2$ ), the mean scores of the completed items were imputed in the missing items, leaving a study sample of 643 women (78% of those included in early pregnancy).

### Statistical methods

Descriptive statistics are provided as mean with standard deviation (SD) or median with interquartile range (IQR). To compare groups chi-square tests or Fisher's exact test were used for categorical data and T-tests or the Mann-Whitney U test for continuous variables as appropriate, depending on their distribution.

Most variables reflecting socioeconomic position (SEP) and level of integration were strongly correlated, although they represent different dimensions of societal and contextual factors. All individual and household markers of maternal SEP and variables related to the level of integration were entered into a principal components analysis (PCA) (Sletner et al., 2014). Two separate, uncorrelated components were extracted. The first component was strongly correlated with the predefined markers of the level of integration such as language skills (three different questions), time of residency, social interaction with ethnic Norwegians and use of Norwegian media, and, was skewed to the right, reflecting that ethnic Norwegians all had high scores. The second component had strong correlations with the predefined individual and household markers of SEP (educational level, occupational class, employment status, renting tenure and rooms per person in the household) and was normally distributed. Both components had Cronbach's  $\alpha > 0.7$ , indicating good internal reliability. As we were mainly interested in the potential effect of low SEP and integration, the PCA scores were further dichotomized as the 40% with the lowest scores versus the 60% with highest scores for SEP and level of integration. The score values may also be difficult to interpret directly from the tables. These categories were chosen to obtain consistency with our previous article related to depression during pregnancy (Shakeel et al.,

2015). There, we examined different cut-off values (20/80 as well as three categories with different cut-off values) but found that the pragmatic 40/60 cut-point had a sufficient number in the lowest category and still carried important information.

An etiological approach was chosen, and a directed acyclic graph (DAG), was drawn prior to the analyses (figure 1), to guide our selection of confounders in the analysis and thereby reduce the magnitude of bias in the estimates produced (Hernan et al., 2002; Shrier and Platt, 2008). In a timeline, ethnic origin was considered as the explanatory variable of greatest interest. Age at inclusion, adverse life events, lack of social support about the time of delivery, history of depression, depressive symptoms in index pregnancy, SEP and gestational diabetes were regarded as potential confounding variables for the association between ethnicity and PPDS.

We first did univariate logistic regression analyses of all possible confounders. The first model included ethnicity, age at inclusion, adverse life events, SEP, self-reported health and depressive symptoms in index pregnancy (model not shown). Based on significance level and clinical importance, variables were included in the further analysis as confounders for the association between ethnicity and PPDS.

We also hypothesized that there could be synergistic effects between having an ethnic minority background and other risk factors, i.e. that different risk factors may operate differently in ethnic minorities and Norwegians.

Interactions between our main explanatory variable ethnicity and other variables were therefore checked by including product terms, one at a time. The significance level of the interaction effects was set to 0.01 to reduce the problem of false positives. In total, we ran seven tests. The only significant interaction was between ethnicity and depressive symptoms in index pregnancy ( $p=0.01$ ).

Thereafter, to explore this interaction effect, a new combined variable with four categories

(“Western European, no depressive symptoms in pregnancy”; “Western European, with depressive symptoms in pregnancy”; “ethnic minority, no depressive symptoms in pregnancy”; and “ethnic minority, with depressive symptoms in pregnancy”) was constructed. Furthermore, we also used the level of social integration as an alternative explanatory variable instead of ethnicity with the same confounders as for ethnicity. As ethnicity and social integration are strongly interrelated, we did not use level of integration and ethnicity in the same model, as this could lead to over-adjustment.

Model 1 included ethnicity and was designed to answer the primary research question, while model 2 included the level of social integration to address our secondary aim (Table 3). As a sensitivity analysis, we also repeated the last analysis in ethnic minority women only. Nagelkerke R<sup>2</sup> provided the goodness of fit of the model. The statistical significance level was set to  $p < 0.05$ . SPSS version 19 (IBM SPSS statistics, NY, USA) was used for all analyses.

## Results

### Characteristics of study sample

Western European women constituted 42.3% of the sample (17.6% from Norway, 1.7% from Sweden, 0.3% from Denmark and 0.5% from other Western European countries and North America).

In total, 57.7% of the 643 women in our sample were ethnic minorities: Pakistan (19.6%), Sri Lanka (9.5%), Middle East (11.2%), East European countries (6.7%), Africa South of Sahara (3.4%), East Asia (6.9%), and South and Central America (1.9%). These women were younger, less educated, more likely to be unemployed, had higher parity and lower SEP compared to Western European women (Table 1). Further, 21.8% of the minority women were in need of an interpreter during the first visit. Those who did not re-attend after the first visit (non-attendants) had slightly low SEP (49.4% vs 37.2%,  $p < 0.01$ ) and low education

(20.8% vs 15%,  $p<0.01$ ), more unemployment (39.3% vs 28%,  $p<0.01$ ), and more were living without a partner (8.9% vs 4.8,  $p=0.04$ )

#### Prevalence of PPDS, median EPDS score and depressive symptoms in pregnancy

Sixty women had EPDS score  $\geq 10$  at the postpartum visit, yielding a crude prevalence rate of 9.3% (95% CI: 7.1-11.6) for the whole study sample (Figure 1) and further, 4.8% (2.3-7.4) for Western European women and 12.7% (9.3-16.1) for the ethnic minorities ( $p=0.001$ ). Using Western European women as the reference, women with Middle Eastern and South Asians ethnic origin had higher prevalence rates; 18.1% (10.3-25.9) and 11.9% (6.9-16.9) ( $p<0.001$  for both) while the prevalence was 9.4% (4.1-14.7) in the merged group of other ethnic minorities. Compared with Western Europeans (1; (IQR) (0-3)), Middle Eastern (median; 4; (1-7)) and South Asian (3; (1-6)), women had higher EPDS scores while other ethnic minorities had (2; (0-5)) – not significantly different from the reference group).

Among women who had depressive symptoms in pregnancy, 28.0 % still had depressive symptoms at the postpartum visit; 33.3% among the Western Europeans and 25.9% among the merged ethnic minority group, (Figure 2a). Among women with PPDS, 72.7% in the Western European group and 33.3% in the merged ethnic minority group also had depressive symptoms in the index pregnancy (Figure 2b).

#### Variables associated with PPDS

In addition to ethnicity, depressive symptoms in the index pregnancy, adverse life events, lack of social support, low SEP and integration were associated with PPDS in univariate analyses, while gestational diabetes was not (Table 2, Table 3).

In multiple regression analyses, depressive symptoms in the index pregnancy was associated with a more than double risk of PPDS both in ethnic Western European and ethnic minority

women, although the OR did not reach statistical significance for ethnic minority women ( $p=0.08$ ). Due to the interactional effect between ethnicity and depressive symptoms in pregnancy, “Western European women with no depressive symptoms in pregnancy” had a substantially lower risk of PPDS (Table 3, Model 1) than ethnic minority women with no depressive symptoms in pregnancy (OR 0.2 (0.05-0.59),  $p=0.005$ ). Adverse life events and lack of social support were also independently associated with PPDS (Model 1).

To investigate our second aim, we replaced ethnicity by level of social integration (Table 3, Model 2). A low level of social integration was associated with an OR of 2.1 (95% CI: 1.1-3.95) for PPDS, adjusted for age, SEP, adverse life events, lack of social support and a history of depression. All these factors except age were independently associated with PPDS in the adjusted models. “History of depression” was chosen instead of “depressive symptoms in the index pregnancy” in Model 2, as the model with “history of depression” had higher  $R^2$  ( $R^2=27.6$ ) than the model with “depressive symptoms in the index pregnancy”, (latter model not shown). No interaction between “mother’s level of social integration” and “history of depression” ( $p=0.80$ ), nor with “depressive symptoms in the index pregnancy” ( $p=0.11$ ) was found.

In the sensitivity analysis exploring the level of integration among ethnic minorities only, we found a similar, but non-significant-, trend for the PCA variable for integration as in the main analysis (results not shown).

## Discussion

In our population-based cohort study from an urban, multiethnic setting, also including women who had recently immigrated and women with poor skills in the majority language, we found a prevalence rate of PPDS of 9.3% for the whole study sample, 4.8% for Western European women and 12.7% for the ethnic minorities. The prevalence was higher in Middle



Eastern and South Asian women than in Western European women, as was the median EPDS score. In contrast to minority women, the majority of the Western European women with PPDS also had depressive symptoms during pregnancy. Recent adverse life events, lack of social support, depressive symptoms in the index pregnancy and ethnic minority background were independently associated with PPDS. Importantly, low social integration was also significantly associated with PPDS when replacing ethnicity in our models.

### **Comparison with other studies**

Prevalence rates for PPD vary considerably across studies (O'Hara and McCabe, 2013). Different contexts, populations and methodology (study design, measures and criteria for PPD, and timing of the assessment) make direct comparison across studies difficult (Dennis and Dowswell, 2013; Dennis and Hodnett, 2007; Eberhard-Gran et al., 2001a). As EPDS in our study was measured about 14 weeks postpartum, our cases might represent more persistent symptoms than studies reporting rates from earlier in the postpartum period. Rates are generally higher in low-income compared with high-income countries (Norhayati et al., 2015). Studies from Turkey, Pakistan, and India (the Tamil population) generally report high prevalence rates (14-40%) of PPD (Ali et al., 2009; Husain et al., 2006; Savarimuthu et al., 2010; Turkcapar et al., 2015). Furthermore, a systematic review of PPD in migrant South Asian women found prevalence rates ranging from 5 to 20%, with ORs 1.8-2.5 in those who were born overseas compared to later generations (Nilaweera et al., 2014).

Relatively few studies have reported results from diverse ethnic communities (Dennis and Dowswell, 2013; Rich-Edwards et al., 2006). However, a systematic review from 2015 of PPD in various immigrant groups included eleven studies from Canada (mostly Asian Indians), three from Australia, and six from Europe. Overall, the OR for PPD was 1.8- 2.2 for immigrant versus native women in adjusted analyses (Falah-Hassani et al., 2015), in

accordance with our findings.

In line with several other studies, we found that regardless of ethnicity, adverse life events, depressive symptoms during pregnancy and depression earlier in life are strongly related to the development of PPDS (Eberhard-Gran et al., 2002; Rich-Edwards et al., 2006; Robertson et al., 2004; Rubertsson et al., 2005).

Our finding that “lack of social support” was strongly associated with PPDS is well supported by other studies (Beck, 2001; Husain et al., 2012; O'Hara and Swain, 1996). Immigrant women may be particularly vulnerable when it comes to childrearing in a new country, as they carry with them their own traditions regarding childbirth and the postpartum period (Evagorou et al., 2016; Gulamani et al., 2013). For instance, in Pakistan and Turkey traditional rituals include 40 days of mandatory rest for the new mother, with practical and emotional support offered by family members (Eberhard-Gran et al., 2010). Usually the mother-in-law and other family members take care of the newborn. However, in cases where emotional support offered by family members or the mother-in-law does not meet the new mother's needs, this may increase the risk of PPDS (Evagorou et al., 2016). Another aspect of cultural differences is the level of physical activity in the postpartum period. In another study from our cohort, we found that South Asian and Middle Eastern women did not increase their level of physical activity from mid-gestation to the postpartum visit, in contrast to what we observed in Western European women (Richardson et al., 2016). As in another study from a high-income country, we did not find a relationship with the gender of the newborn (Husain et al., 2012). SEP is associated with PPDS across different cultures and countries (Robertson et al., 2004; Rubertsson et al., 2005) and can further influence adjustments to motherhood and overall emotional health (Eberhard-Gran et al., 2010). In another study from our cohort, we found that low SEP was independently associated with depression during pregnancy (Shakeel et al., 2015). In the present study,

however, low SEP was independently associated with PPDS only in the model where we used social integration instead of ethnicity, probably in part due to the strong association between ethnicity and SEP and the relatively small sample size and number of cases.

Gestational diabetes is a common complication of pregnancy, is more frequent in ethnic minorities (Jenum et al., 2010), and the diagnosis is considered stressful at least in the short term (Crowther et al., 2005). There are contradictory findings in the literature about gestational diabetes and its association with PPDS (Barakat et al., 2014), and we did not find any significant associations between gestational diabetes in the index pregnancy and PPDS.

Interestingly, we found that a higher proportion of Western European women with PPDS also had depressive symptoms in pregnancy, indicating that the majority of these PPDS cases probably could be identified if screened during pregnancy. By contrast, although ethnic minorities in our study had at least a double risk for depressive symptoms both in pregnancy and postpartum, the proportion of new cases was higher compared with Western Europeans at the postpartum visit. Hence, the majority of ethnic minority women with PPDS might be more difficult to identify during pregnancy.

To better understand the increased risk of PPDS in ethnic minorities, we explored the level of social integration in the mainstream Norwegian society and found a strong independent association with PPDS. Our social integration variable covers several aspects and our study is one of the few that addresses this important issue in more detail. Differences in PPDS risk related to level of integration and time of residence may reflect different stages of acculturation. The observed heterogeneity in prevalence of PPDS among the ethnic minority groups might be a reflection of different levels of integration. The lack of interaction between the integration variable and depressive symptoms in pregnancy, despite a strong interaction between ethnicity and depressive symptoms in pregnancy, could also suggest that

social integration might play an important part in the increased rate of new cases with depressive symptoms at the postpartum visit in ethnic minority women.

### **Strength and limitations**

Our study has several strengths, including the prospective cohort design, the population-based multiethnic sample with inclusion of women in need of an interpreter, high inclusion rates in all ethnic groups, and the broad range of variables, including factors related to SEP, social integration and use of the DAG approach to capture true confounders. We also recorded use of any medication, including antidepressants.

Furthermore, we used the EPDS measure. This is developed for the identification of PPDS, and has good sensitivity and specificity when tested against other assessment methods (Murray and Carothers, 1990). When tested against the gold standard (the DSM IV criteria for major depression), in an earlier Norwegian study of postpartum women, a cut-off point of  $\geq 10$  had 100% sensitivity and 87% specificity (Eberhard-Gran et al., 2001b). The EPDS and its validated translated versions have demonstrated good psychometric properties across different contexts and cultures (Aydin et al., 2004; Benjamin D, 2005; Berle et al., 2003; Dr Jann Marshall, 2006; Husain et al., 2011). In accordance with other epidemiological studies, we used score  $\geq 10$  to define PPDS, indicative of increased risk of depression (Harris et al., 1989). EPDS is primarily a screening instrument, and in clinical practice, a diagnostic interview should be carried out to identify cases of depression in need of treatment. Only one of the women with PPDS used antidepressant medication, while five women on such medication had an EPDS score  $< 10$ , indicating clinical effect. By measuring EPDS symptoms at postpartum week 14, which is somewhat later than the recommended time period in clinical practice (six to eight weeks postpartum), we have probably included cases with more persistent symptoms, but less persistent cases were probably missed.

However, our study has several limitations. Most importantly, the number of PPDS cases

was limited. We have PPDS data for 78% of included women, implying a loss to follow-up of 22%, which is lower than in other studies (Ganann et al., 2016). Nevertheless, we found indications of some selection bias, which is often the case in cohort studies with longer follow-up-times. Women in the current study sample had slightly higher SEP, were more educated and less unemployed, and were more often living with a partner compared to the non-respondents.

Further, information about history of depression was collected postpartum, which may have led to some memory or recall bias, and some of those who reported a history of depression, may have been referring to an episode in the index pregnancy. The cross-cultural validity of the EPDS is an important issue (Shakeel et al., 2015). As our primary aim was to compare the symptom load in different ethnic groups with mainly Asian and African backgrounds in Europe living in the same residential area in the capital of Norway, we used the same cut-off value for all the women. Lastly, heterogeneity within the ethnic groups is another concern, not least in the merged ethnic minority group, and we do not presume homogeneity within the ethnic minority groups. Nevertheless, we still consider the substantially higher symptom load in the minority compared with the majority population residing in the same area important to report.

### **Implications**

The implications of our findings are that clinicians should be aware of the increased risk of PPDS among ethnic minorities compared to Western European women. Women with clinical depression should be offered evidence-based care accordingly (Dennis and Allen, 2008). From a public health perspective, knowledge of factors that can explain why the ethnic minorities are at increased risk is of particular importance. Some ethnic groups may be more vulnerable. Our findings clearly indicate that integration is a cue. Furthermore, our

results suggest that three of four Western European women with PPDS already had depressive symptoms in pregnancy. In ethnic minority women, however, the majority of PPDS cases would probably not be identified by screening during pregnancy only. Lastly, there is a need for more nuanced studies among specific ethnic groups in the future.

National screening programs based on the EPDS to identify women with perinatal depression are still under debate (Howard et al., 2014; Norweigan directorate of health, 2016), as there is a lack of strong trial evidence of cost-effectiveness and acceptability among new mothers.

The National Institute of Health and Care Excellence (NICE) guidance recommends that, in the UK, general practitioners can consider asking the two Whooley questions to identify potential depression in vulnerable women in need of enhanced support and treatment. There is little difference in the diagnostic accuracy between the Whooley questions and the EPDS, but Whooley questions could be a less time consuming alternative for busy clinicians (Bosanquet et al., 2015; Howard et al., 2018).

## Conclusion

Our main finding was that ethnic minority women, particularly from the Middle East and South Asia, were at higher risk of developing PPDS. Recent adverse life events, lack of social support, and depressive symptoms in index pregnancy were independently associated with PPDS. However, there were relatively more new cases postpartum in the ethnic minority groups, while a higher proportion of Western European women with PPDS also had depressive symptoms in pregnancy. Furthermore, the significant association with level of social integration may suggest that this could at least partly mediate the increased risk in ethnic minorities. However, cultural factors and SEP most probably also contribute.

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## **Authors' contributions**

NS performed the statistical analysis, supported by RSF (except the PCA analyses), wrote the first draft and revised the paper, LS contributed with the data acquisition and performed the PCA analyses on socio-economic and integration variables, ME-G, KS, and EWM contributed with expert knowledge about the EPDS and other instruments to capture depressive symptoms. AKJ initiated and was the project leader of the STORK Groruddalen study. All authors contributed to the interpretation of data, revised the manuscript critically, checked for clarity and content, and approved the final version.

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## **Competing interest**

The authors declare that they have no competing interest.

## **Ethics approval and consent to participate**

The study was approved by The Regional Committee for Medical and Health Research Ethics for South Eastern Norway (reference number: 2007.894) and The Norwegian Data Inspectorate. All participants gave their written informed consent.

## **Authors' contributions**

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### Conflict of interest

The authors declare that they have no conflict of interest.

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**Figure legends:**

Figure 1: Directed Acyclic Graph, DAG, for the association between ethnicity and postpartum depressive symptoms, PPDS

Figure 1

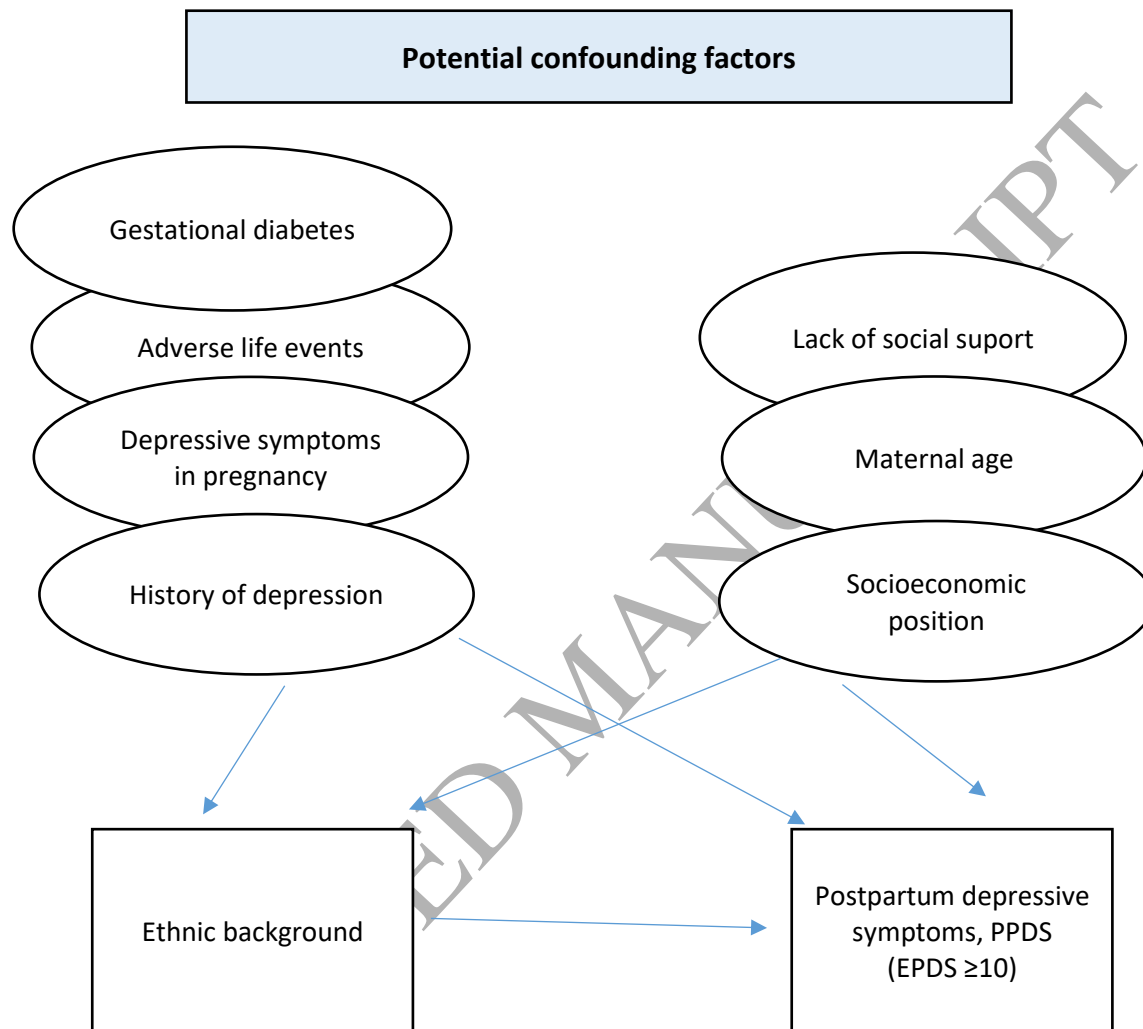


Figure 2: Proportion with postpartum depression (%; 95% confidence intervals) by main ethnic groups

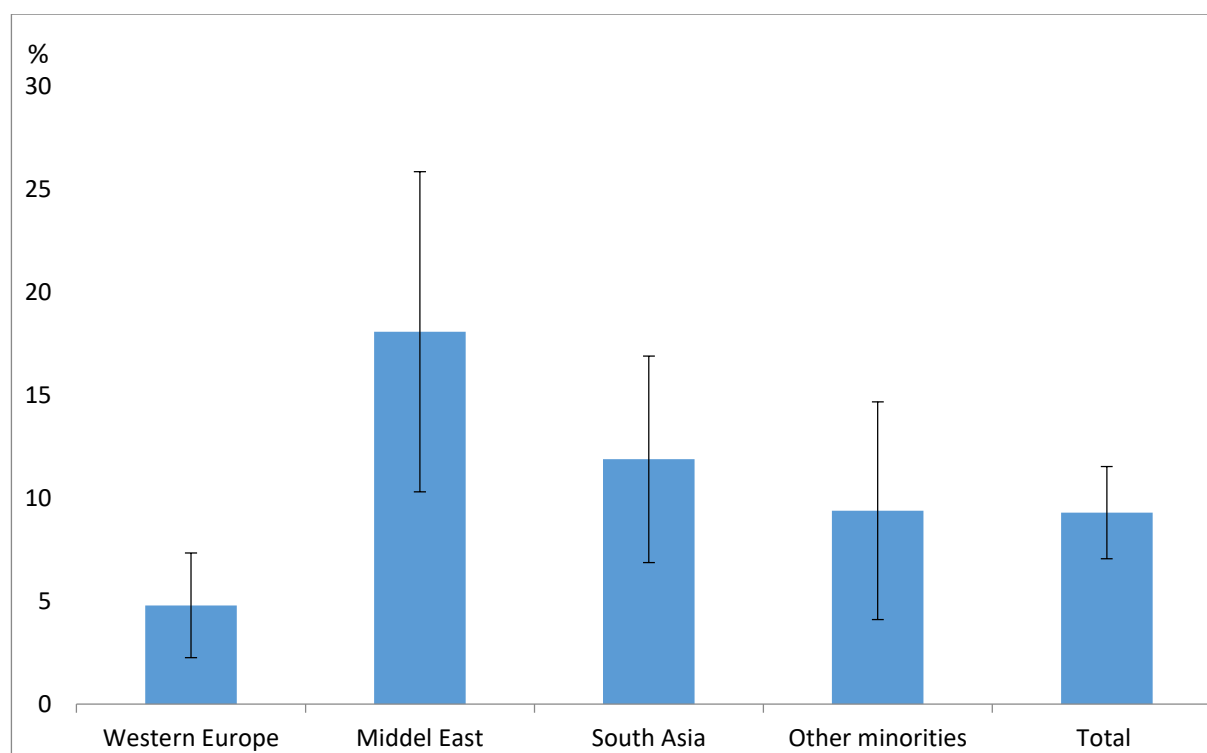


Figure 3a: Proportion of those who were depressed in gestational week 28 and still depressed in postpartum (% , 95% confidence Interval)

Figure 3b: Proportion of those with postpartum depression who were also depressed in gestational week 28 (% , 95% confidence Interval)

Figure 3a

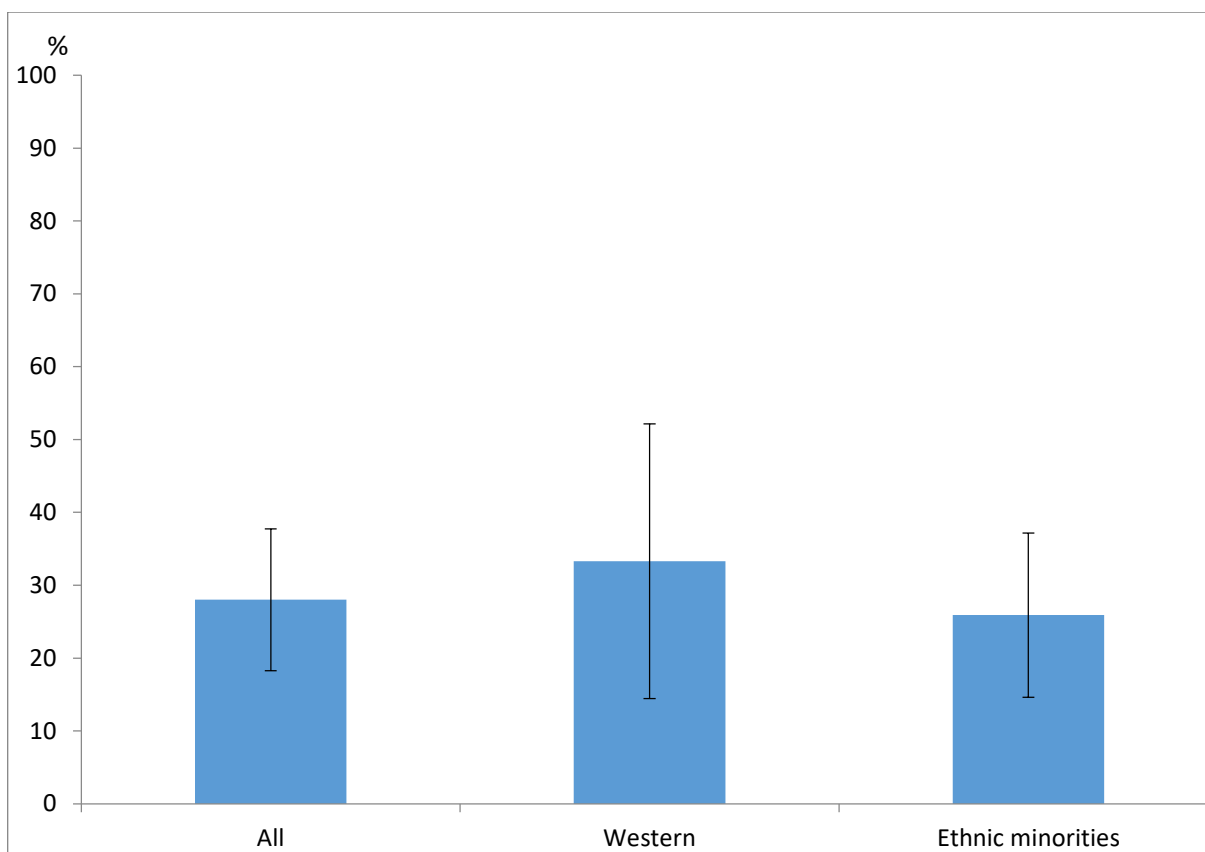


Figure 3b

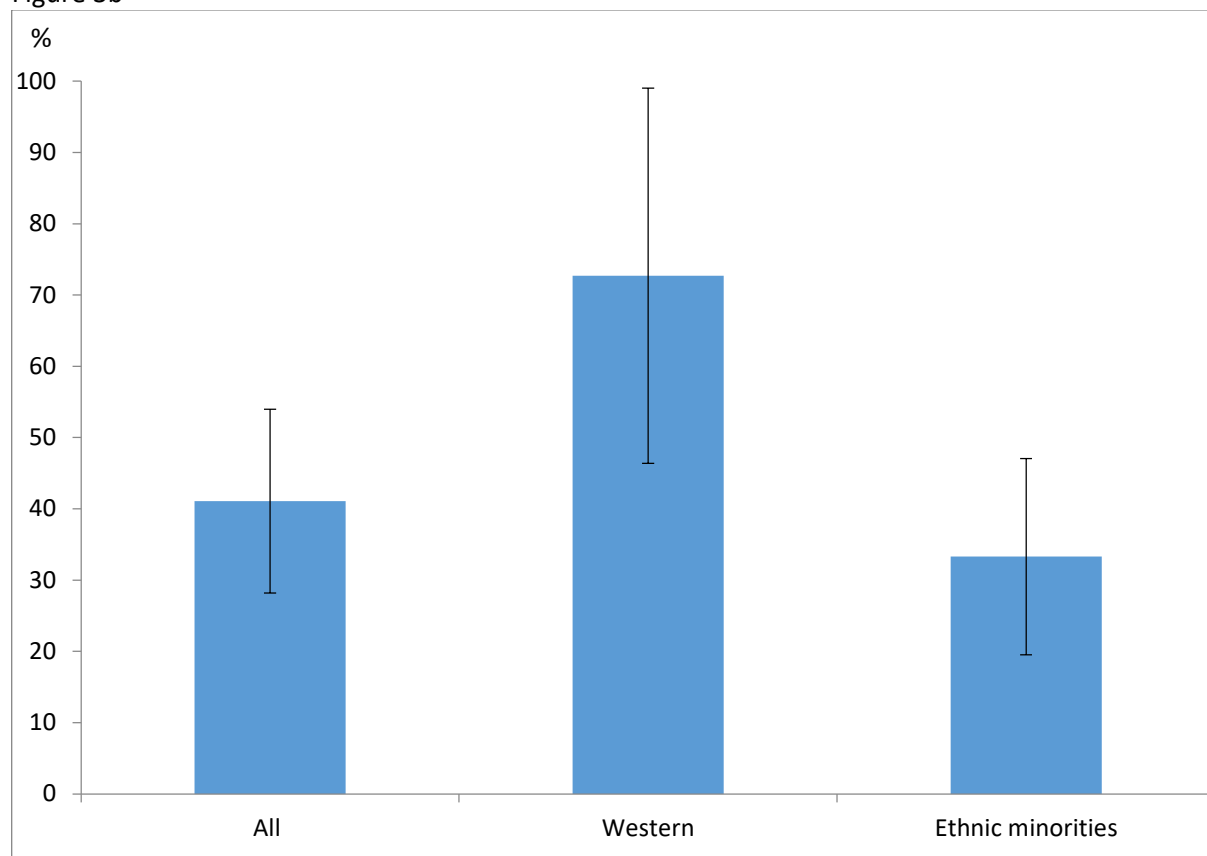


Table titles:

Table 1: Sample Characteristics for Western European and ethnic minority women

	Total N=643	<sup>1</sup> Western European n=272 (42.3 %)	<sup>2</sup> Ethnic minority n=371 (57.7 %)
Age at inclusion, mean (SD)	29.9 (4.81)	31.0 (4.40)	29.0 (4.88)
Weeks postpartum, mean (SD)	14.2 (2.68)	14.1 (2.60)	14.3 (2.74)
Nulliparous	298 (46.3)	140 (51.5)	158 (42.6)
<sup>3</sup> Single parenthood	22 (3.4)	5 (1.8)	17 (4.6)
Educational			
<10 years schooling	96 (15.0)	5 (1.9)	91 (24.7)
Secondary level, (10-12 y)	249 (39.0)	82 (30.4)	167 (45.3)
Up to 4 years of further education	196 (30.7)	111 (41.1)	85 (23)
University/college	98 (15.3)	72 (26.7)	26 (7)
<sup>3</sup> Adverse life events			
0 or 1 event	470 (77.6)	206 (81.1)	264 (75.0)
2 events	85 (14.0)	27 (10.6)	58 (16.5)
3 or more events	51 (8.4)	21 (8.3)	30 (8.5)
<sup>3</sup> Proportion with low score for socioeconomic position	239 (37.2)	50 (18.4)	189 (50.9)
<sup>4</sup> Proportion with low score for social integration	247 (38.4)	16 (5.9)	231 (62.3)
Previous history of depression	137 (21.0)	73 (26.2)	64 (17.2)
<sup>5</sup> Depressive symptoms in index pregnancy	82 (13.1)	24 (9.2)	58 (16)
Lack of social support around the birth period	79 (12)	28 (10)	51 (13.5)
Offspring gender			
Male	309 (50.2)	135 (51.7)	174 (49)
Female	307 (49.8)	126 (48.3)	181 (51)
Use of interpreter during the first visit	81 (12.6)	0	81 (21.8)
<sup>6</sup> Gestational diabetes	86 (13.7)	31 (11.6)	55 (15.3)



Table 2: Characteristic of women with and without postpartum depression

	Depressive symptoms n=60 (9.3 %)	No depressive symptoms n=583 (%)	P-value
Ethnic minority women	47 (12.7)	324 (87.3)	<0.01
Western European women	13 (4.8)	259 (95.2)	
Age at inclusion, mean (SD)	28.8 (4.47)	30.0 (4.81)	0.07
Weeks postpartum	14.1 (3.50)	14.2 (2.59)	0.80
Nulliparous	27 (45)	271 (46.5)	0.83
<sup>1</sup> Single parenthood	3 (5.1)	19 (3.3)	0.45
Educational level			
<10 years schooling	12 (20)	84 (14.5)	0.44
secondary level, 10-12 years	26 (43.3)	223 (38.5)	
up to 4 years of further education	15 (25)	181 (31.3)	
university/college	7 (11.7)	91 (15.7)	
<sup>2</sup> Adverse life events			
0 or 1 event	24 (44.4)	446 (80.8)	<0.001
2 events	13 (24.1)	72 (13.0)	
≥ 3 events	17 (31.5)	34 (6.2)	
Proportion with low score for socioeconomic position score	35 (58.3)	204 (35.0)	<0.001
Proportion with low score for social integration	31 (51.7)	216 (37.0)	0.03
Previous history of depression	29 (49.2)	108 (18.6)	<0.001
<sup>3</sup> Depressive symptoms in index pregnancy	23 (41.1)	59 (10.4)	<0.001
Lack of social support around the birth period	17 (28.3)	61 (10.5)	<0.001
Offspring gender			
Male	25 (43.9)	284 (50.8)	0.32
Female	32 (56.1)	275 (49.2)	
Use of antidepressive at the postpartum visit	1 (1.7)	5 (0.9)	
Gestational diabetes with WHO criteria	6 (10.4)	80 (14)	0.436

Table 3: Odds ratio (OR) for postpartum depression, unadjusted and adjusted values, model with ethnicity or social integration

	Unadjusted OR			Adjusted OR					
	OR	95 % CI	P-value	*Model 1 (R <sup>2</sup> =29)	95 % CI	P-value	**Model 2 (R <sup>2</sup> =27.6)	95 % CI	P-value
Ethnic minority, not depressed in pregnancy (ref)									
Western European, no depressive symptoms in pregnancy	0.12	0.035-0.388	<0.001	0.2	0.05-0.59	0.005			
Western European, depressive symptoms in pregnancy	4.6	1.81-11.56	0.001	4.0	1.36-11.43	0.012			
Ethnic minority, depressive symptoms in pregnancy	3.2	1.59-6.41	0.001	2.1	0.93-4.67	0.076			
Age at inclusion	0.95	0.90-1.0	0.068	0.95	0.89-1.02	0.127	0.92	0.86-0.99	0.020
<sup>1</sup> Adverse life-events (0-1=ref)									
2 events	3.4	1.64-6.89	0.001	2.9	1.34-6.35	0.007	2.3	1.03-5.15	0.041
3 or more events	9.3	4.56-18.95	<0.001	6.4	2.77-14.88	<0.001	6.4	2.78-14.55	<0.001
Mother's socioeconomic position, SEP (highest 60%=ref)									
Lowest 40 %	2.6	1.52-4.47	0.001	1.6	0.83-3.08	0.165	2.4	1.27-4.58	0.007
Lack of social support (no=ref)									
Yes	3.4	1.82-6.28	<0.001	3.4	1.59-7.07	0.001	3.3	1.57-6.81	0.002
Mothers's level of social integration (highest 60%=ref)									
Lowest 40 %	1.8	1.07-3.10	0.028				2.1	1.11-3.95	0.022
History of depression	4.7	2.70-8.21	<0.001				3.3	1.66-6.44	0.001
<sup>2</sup> Depressive symptoms index pregnancy	6.0	3.31-10.92	<0.001						
Weeks postpartum	0.99	0.89-1.09	0.796						
Offspring gender (boy=ref)	1.3	0.76-2.29	0.319						
<sup>3</sup> Gestational diabetes	0.7	0.30-1.70	0.438						

<sup>1</sup>Gestational week 28 to postpartum,<sup>2</sup>EPDS ≥10 during pregnancy<sup>3</sup>According to WHO 1999 definition (fasting plasma glucose ≥7.0 mmol/l and/or 2-hour plasma glucose ≥7.8 mmol/l)

\*Model 1: multiple logistic regression analysis with adjusted ORs for included variables

\*\* Model 2: multiple logistic regression analysis with adjusted ORs for included variables