

# Are labor pain and birth experience associated with persistent pain and postpartum depression?

## A Prospective Cohort Study

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### Abstract

**Background and aims:** A considerable research-literature focuses on pain during labor and associations with postpartum persistent pain and depression, with findings pointing in various directions. The aim of this study was to examine the role of labor pain and overall birth experience in the development of pain and depression eight weeks after delivery.

**Methods:** The study sample was drawn from the Akershus Birth Cohort. Data from multiple sources were used, including the hospital's birth record (n=4391), questionnaire data from gestational week 17 of pregnancy (n=3752), eight weeks postpartum (n=2217), and two questions about pain and birth experience asked within 48 hours after delivery (n=1221). The Edinburgh Postnatal Depression Scale was used to measure postpartum depression, a single question was used to measure persistent pain eight weeks postpartum, while pain and birth experience were measured by numeric rating scales. A history of pre-pregnant depression and chronic pain were measured through self-report questions in gestational week 17. A total of 645 women had complete data from all sources. We applied multiple imputation techniques to handle missing responses on the two questions about pain and birth experience.

**Results:** The results showed that neither labor pain nor birth experience were associated with persistent pain eight weeks postpartum, whereas pain before pregnancy (OR 3.70; 95% CI 2.71-5.04) and a history of depression (OR 2.31; 95% CI 1.85-2.88) were statistically significant predictors of persistent pain. A negative birth experience was significantly (OR 1.16; 95% CI 1.04-1.29) associated with postpartum depression, whereas labor pain intensity was not. A history of depression (OR 3.95; 95% CI 2.92-5.34) and pre-pregnancy pain (OR 2.03; 95% CI 1.37-3.01) were important predictors of postpartum depression eight weeks after delivery.

**Conclusions and implications: Whilst the relationship between labor pain intensity and postpartum pain and depression remain unclear, our results do imply the need to screen for previous depression and chronic pain conditions in pregnant women, as well as consider preventive measures in those who screen positive.**

**Keywords:** labor; pain; postpartum depression; postpartum persistent pain; birth experience

## 1 INTRODUCTION

Pain is a fundamental feature of childbirth, and birth experiences can vary widely. Yet little is known about the potential long-term consequences of labor pain intensity and overall birth experience. Two common health concerns that a substantial number of women struggle with after giving birth are persistent pain and symptoms of depression. The incidence of persistent postpartum pain (assessed 2-3 months after delivery) ranges from up to 10% after vaginal delivery, to up to 18% after caesarean delivery (1, 2), while postpartum depression (usually assessed within the first 3-6 months postpartum) has an incidence of about 12% (3). Post-partum pain is usually defined as pain that began at the time of labor and delivery and include a location that could be ascribed to the delivery (pelvis, perineum, abdomen) (2), but more general descriptions are also common (e.g. painful perineum) (4). Both postpartum pain and depression could have debilitating consequences. Postpartum depression has been shown to interfere with the maternal-infant bonding, and increase the risk of long-term psychological sequelae in the child (5-7), whilst persistent pain can have significant consequences for coping with daily activities, as well as increase the risk of more permanent pain conditions (4).

Some studies suggest there is an association between labor pain and postpartum depression, suggesting that managing labor pain and early postpartum pain decreases the risk for depression (8-10). A recent study even suggest that effective labor pain management with epidural analgesia was associated with reduced postpartum depression symptoms (11). However, the explained variance of labor pain was minimal in this study, and other studies have not been able to find this association (12, 13). High-quality prospective studies have therefore been called for in order to understand the complex interplay between intrapartum pain and postpartum depression (14). Other established risk factors for postpartum depression involve prenatal depression, childcare stress, life stress, social support, prenatal anxiety and a history of depression (15, 16).

Persistent postpartum pain has been the subject of few research articles, despite a high incidence and potentially debilitating nature of such pain (4). Known predictors of persistent postpartum pain involve labor pain intensity in vaginal delivery, and pain shortly after caesarean delivery (17). Other predictors of persistent pain involve a history of previous pain, and the incidence of persistent pain is generally higher after caesarean delivery than after vaginal delivery (2, 18, 19).

It is reasonable to assume that not only the labor pain intensity, but also the women's overall birth experience may increase the risk of late effects, particularly the risk for postpartum depression. In several previous studies a negative or poor birth experience has indeed been associated with a higher score on the Edinburgh Postpartum Depression Scale (20, 21), while other studies indicate no such associations (22). Some of these disagreements may be due to methodological differences, such as how and when the questions were asked. In many cases the questions were asked in retrospect, increasing the risk of memory bias. As far as we know, no previous studies have prospectively investigated the association between birth experience and persistent postpartum pain.

The aim of this study was to examine the role of labor pain and overall birth experience in the development of pain and depression eight weeks after delivery. We hypothesized that both labor pain intensity and birth experience would be associated with postpartum depression and persistent pain after delivery.

## 2 METHODS

### 2.1 Design

The study was a longitudinal cohort study, which examined the role of labor pain and overall birth experience in the development of pain and depression eight weeks after delivery.

## 2.2 Data source and study population

This study sample was part of the Akershus Birth Cohort Study (ABC) (23), which targeted all women scheduled to give birth at Akershus University Hospital. The hospital is located near Oslo, the capital of Norway, and serves a total population of approximately 400 000 individuals from both urban and rural surroundings. On average, 3500 women gave birth at the hospital each year during the study period.

## 2.3 Recruitment procedure

Women were recruited at their routine fetal ultrasound examination performed around gestational week 17, from November 2008 to April 2010. As part of the public antenatal care program, this examination is offered free of charge to all women in the hospital's catchment area. Pregnant women who were able to complete a questionnaire in Norwegian were eligible for the Akershus Birth Cohort. There were no exclusion criteria. Consenting women were handed a questionnaire at gestational week 17 and were thereafter followed up with another questionnaire before as well as eight weeks after delivery. Figure 1 displays a flowchart of the recruitment and retention of study participants. In total, 2217 women returned the post-partum questionnaire 8 weeks after delivery, which is 48% of those originally included in the cohort (2217 out of 4662) and 59% of those who returned questionnaire 1 in pregnancy week 17 (2217 out of 3752). The number of eligible women dropped somewhat 8 weeks postpartum, as some women had moved or were withdrawn from the study because of severe complications (see figure 1 for details).

We used questionnaire data from week 17 of pregnancy as well as eight weeks after delivery. We also used data from the hospital's birth record. The birth record is completed by the hospital staff members and contains sociodemographic and medical information about the mother, child, pregnancy and birth.

An additional brief questionnaire (about labor pain and birth experience) was handed out to the women within 48 hours after delivery, as well, between May 2009 and September 2010 (N=2389), and 51 percent (1 221 out of 2 389) of the women included in the study answered (Figure 1). In total, 645 women had complete data from all data sources used in the current paper (i.e. questionnaire in week 17, the two questions after delivery, the questionnaire 8 weeks postpartum, and birth record data).

All women asked to participate were given written information explaining the purpose of the study and were informed that participation was voluntary. Informed consent was obtained from all participants. The study was approved by Regional Committee for Ethics in Medical Research in Norway, approval number S-08013a. The study is performed and reported according to STROBE guidelines (24).

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## 2.4 Measures

### 2.4.1 Labor pain and birth experience

Within 48 hours after delivery, labor pain was assessed by the following question: "How intense pain did you feel during labor?" The question was communicated as an overall indication of their pain during labor and the questionnaires were filled in by the participants. The pain was measured with a numeric rating scale, which presents a common and reliable way of measuring pain (25). The answers were scored from 0 (no pain) to 10 (the strongest pain you can imagine). Thereafter, birth experience was measured using a numeric rating scale and based on the following question: "What was your experience of the birth?". Again, the question was communicated as an overall indication of their birth experience, with no specific details about different parts of the delivery or hospital stay. The answers were scored from a minimum of 0 to a maximum of 10 ("very good" to "extremely bad"). These two variables were the exposure variables in the current study.

### 2.4.2 Measure of postpartum depression

The Edinburgh Postnatal Depression Scale (EPDS) was applied as a measure of post-partum depression eight weeks after delivery, and was one of the two outcomes of the study. The EPDS is a 10-item self-rating questionnaire developed

to screen for depression in the postpartum period; it addresses symptoms present during the last 7 days (26). Each question has 4 possible responses, related to scores from 0 to 3, for a maximum score of 30. In the current study the Cronbach alpha coefficient for the EPDS was 0.851. A cut-off of 10 or above was found to have good psychometric properties for a depression among Norwegian postpartum women (27). We applied the recommended cut-off of 10 or more to define possible cases of postpartum depression. For readability purposes, a score of 10 or more on EPDS will be referred to as “postpartum depression”.

### 2.4.3 Persistent postpartum pain

Presence of persistent pain was assessed eight weeks after delivery by the following question: “Have you been bothered by persistent or frequently recurring pain during the last two weeks?” (coded: yes/no).

### 2.4.4 Potential confounders

In the first questionnaire (gestational week 17), the women were asked about the experience of frequently recurring or chronic pain that lasted for more than 3 months before pregnancy (coded: yes/no), as well as previous depression (coded: yes/no). As both of these factors are known predictors of persistent post-partum pain and depression respectively, they were included as potential predictors and/or confounders.

### 2.4.5 Other study factors

The following information regarding outcome of delivery was collected from the birth files at the hospital: mode of delivery (vaginal, elective or emergency cesarean section), use of epidural analgesia (EDA), cervical dilatation in cm when EDA was given, duration of labor, and presence of perineal tears. Information on educational level, marital status, and maternal age was also obtained from the maternity ward birth records. Years of education was coded as:  $<12$  or  $\geq 12$ . Information on parity was obtained in the first questionnaire and coded “para 0” or “para  $\geq 1$ ”.

## 2.5 Statistical methods

Logistic regression analysis was used to estimate univariate and multivariate regression models. To handle the missing responses on the two questions asked within 48 hours after labor (labor pain and birth experience), we applied multiple imputation techniques where each missing value is replaced with  $m = 10$  simulated values prior to analysis. This approach was considered appropriate as the data was missing at random (28), in which case multiple imputation will increase power and reduce bias (29). A total of 40 variables were included in the imputation models. They included personality variables, psychological variables such as previous/ongoing depression, anxiety and sleep disorders, social variables such as sick leave and social support, and characteristics of the labor and the child, both self-reported and registered in the medical records. The regression models were run without adjustment for missing as well, to investigate consistency across methodological approaches. The correlation analysis of labor pain and birth experience was run without adjustment for missing.

## 3 RESULTS

### 3.1 Participants

Mean age at delivery was 30.7 years and close to half of the women (49%) were first-time mothers (Table 1). The vast majority (97.6%) was married or cohabitating and did not smoke at the time of delivery (95.7%). Education was at a higher level in 59%. Mean duration of delivery was 6.8 hours (nulliparous 8.0h, multipara 5.1h), which is comparable to previous national data (30). Epidural analgesia was offered to 26% at mean cervical dilatation 6.5 cm (Table 1). Pain intensity ranged from 0 to 10 on the numeric rating scale and median score was 9 (figure 2), while birth experience had

an average of 2.3 (where a lower score indicates a better experience). There was a low grade correlation between labor pain and labor experience (Pearson correlation coefficient 0.20,  $p < 0.01$ ) (Figure 3).

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### 3.2 Factors associated with persistent pain

Eight weeks after delivery, 28% ( $n=596$ ) of the women reported of persistent pain. Persistent pain occurrence was 26% ( $n=483$ ) after vaginal delivery and 36% ( $n=113$ ) after caesarean delivery.

None of the exposure variables (*pain* and *birth experience*) were associated with postpartum pain eight weeks after delivery (Tables 2a and 2b). However, both a history of pain (OR 4.11; 95% confidence interval 3.1-5.4) and depression before pregnancy (OR 2.40; 95% CI) were significantly associated with postpartum pain at eight weeks in both univariate and multivariate models. Additionally, cesarean delivery and EDA during delivery were associated with postpartum pain at eight weeks in both univariate and multivariate models.

We also ran the analyses without imputation of missing values, which demonstrated similar results as the missing adjusted analyses (see supplementary table 1 and 2).

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### 3.3 Factors associated with postpartum depression

Eight weeks after delivery, 12% ( $n=264$ ) of the women reported a score of 10 or more on EPDS, indicating postpartum depression. Prevalence of postpartum depression was 11.8% ( $n=220$ ) after vaginal delivery and 13.8% ( $n=44$ ) after caesarean delivery.

Adjusted for prenatal and intra-partum factors, *birth experience* (table 3b) but not *pain* (table 3a) were significantly associated with risk for postpartum depression eight weeks after birth. A history of depression (OR 4.46) and pain before pregnancy (OR 2.35) were statistically significant factors, whereas parity and intra-partum clinical factors were not associated with postpartum depression.

We also ran the analyses without imputation of missing values, which demonstrated similar results as the missing adjusted analyses (see supplementary table 1 and 2).

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## 4 DISCUSSION

In this longitudinal study of more than 2000 women, we found that pain intensity during labor was not associated with postpartum depression or persistent pain eight weeks after delivery. A negative birth experience was, however, associated with a slightly increased risk for postpartum depression. A history of depression and chronic pain before pregnancy were both important predictors of postpartum pain and depression eight weeks after delivery.

## 4.1 Postpartum pain and depression incidence

Persistent pain after delivery was reported by 28% of the women, with a substantially higher incidence after caesarean delivery (36%) than after vaginal delivery (26%). This incidence rate is higher than what has been found in previous studies. Eisenach *et al* reported an eight week pain incidence of approximately 10%, with a minor difference between vaginal delivery (10%) and caesarean delivery (9.2%) (31), while Bijl *et al.* found an incidence rate of *any* pain to be 22% and *significant* pain of 14% three months after delivery (32). Conversely, another study reported of considerably more pain problems after birth; 79% of mothers with a caesarean section experienced pain at the incision during the first two months postpartum, while 48% of mothers with vaginal births experienced a painful perineum (4). The different incidence rates are most likely attributable to measurement issues. For instance, the studies by Eisenach *et al* and Bijl *et al* ask specifically about pain related to the delivery, Declercq asked even more specifically about pain in perineum or at the incision during the last two months, while we asked a more general question about persistent or recurring pain (anywhere) the preceding two weeks. The postpartum pain rate that we observed could thus include pain not related to delivery, and thus produce a higher incidence rate than in some previous studies, yet a lower incidence rate than studies with a wider time frame. Given the multidimensional nature of persistent pain (33), we nevertheless argue that persistent pain postpartum is relevant to study regardless of perceived attributable cause or anatomical location.

Postpartum depression was reported by 12% of the women, with a slightly higher incidence after caesarean delivery (13.8%) than after vaginal delivery (11.8%). These numbers are comparable to previous studies (31, 34-37), and confirm that postpartum depression is a frequently occurring problem among laboring women.

## 4.2 Associations between labor pain and postpartum pain/depression

None of our hypothesized associations between pain intensity during labor and postpartum pain and depression were confirmed. Nevertheless, the lack of associations could be related to methodological issues. The parturients were asked to rate their intra-partum pain and birth experience within 48h after delivery. Recall bias in patient reported pain intensity is documented in studies of labor pain (38), and intra-partum pain ratings tend to be higher than the postpartum scores (39). Moreover, the peak-and-end rule in pain is valid for labor pain (40) and may explain why the women report severe labor pain regardless of analgesic treatment: They remember and report the peak pain intensity. In our study, the parturients remembered the labor pain as very intense. Actually, more than 50% of the participants reported pain intensity as 9 or 10 on a NRS 0-10 (see figure 2). The lack of association between pain intensity during labor and persistent pain and postpartum depression may therefore partly be caused by a ceiling effect. Nevertheless, the literature is inconclusive when it comes to these associations; some suggest that there is an association (10) and that better pain management during birth could prevent postpartum depression (9, 11, 41), whilst others do not find any preventive effects of analgesia (12, 13, 37). The conflicting findings could be related to methodological issues as mentioned, but could also be related to differences in medical procedures in the various clinics. In two of the studies that linked epidural labor analgesia to a decreased risk of postpartum depression, epidural was given upon request (41, 42), implying that it was given at an earlier point in time than in our study where it was provided fairly late. Randomized studies of epidural analgesia are challenging, but not impossible. Two recent studies demonstrate this (43, 44), and could serve as a model for future studies that could include postpartum pain and depression as outcomes as well. Nevertheless, postpartum pain and depression is most likely a result of multiple etiological factors, and the jury is still out on whether labor pain intensity is one of them. After all, one might question the plausibility of considering a single event, e.g. labor pain, crucial for postpartum mental health and persistent pain in the context of a lifetime perspective (45).

## 4.3 Associations between birth experience and postpartum pain/depression

Partly in line with our hypothesis, a more negative birth experience was significantly associated with postpartum depression, but not with persistent pain, eight weeks after delivery. The birth experience represents a synthesis of many components, including labor pain. A review of studies of maternal satisfaction concluded that personal expectations, the amount of support from caregivers, the quality of the caregiver-patient relationship, and involvement in decisions are more important than labor pain (46). A UK population based study supports the relation between overall birth experience and depression. This is further corroborated by a recent intervention study where mindfulness training, carefully tailored to address fear and pain of childbirth, lead to important maternal health benefits in the women, including prevention of

postpartum depressive symptoms (47). It is also in line with a recent study where they found no direct effect of EDA on postpartum depression, but some support for an indirect effect through birth experience (37). We found a significant, but low grade, correlation between labor pain and birth experience, and it is likely that labor pain and treatment of labor pain may affect birth experience to some extent.

#### 4.4 Pain and depression before pregnancy and postpartum pain/depression

An interesting and somewhat surprising finding in our study was the strong associations between both persistent pain and depression before pregnancy and pain and depression eight weeks after delivery. Although Eisenach et al did not find that previous persistent pain predicted postpartum pain, other studies of postpartum as well as post-surgical pain have demonstrated a consistent association between previous pain conditions and incidence of postpartum or post-surgical pain (18, 48). The same is true for postpartum depression, where a history of depression is a consistent predictor of postpartum depression (15). However, the association between a history of depression and postpartum *pain*, or a history of persistent pain and postpartum *depression*, has never been reported before as far as we know. While chronic pain and depression has been demonstrated to be closely related in the general pain literature (49), very little is known about this association when it comes to obstetric patients. Besides from adding to our understanding of the complex etiology of both postpartum pain and depression, we believe that our findings could add to the pool of significant risk factors for disabling postpartum health concerns. Providing replications of our findings, these risk factors could be included in a screening procedure to identify pregnant women at risk of developing postpartum pain and depression.

#### 4.5 Epidural and postpartum pain

In contrast to other reports, we found a positive correlation between labor epidural and pain eight weeks postpartum. Epidural was administered only to women with severe intra-partum pain. In other words, epidural may be a marker of high pain intensity. This association may be confounded by a common risk for both severe pain during labor and persistent postpartum pain. Only 26% of the women had epidural, and at a mean cervical dilatation of 6.5 cm. This may be regarded as a low frequency of epidurals, and probably provided at a later point in time than optimal (50). Epidural rates in general vary a lot between birth clinics, and reflects differences in clinical practice and the delivering women's expectations. The safety of early epidural is well documented (51), but still many laboring woman are encouraged to delay epidural analgesia. Furthermore, women experiencing perinatal distress are much more likely to use epidural (52). The use of epidural could thus be a marker of distress as well, which could explain the increased risk of persistent postpartum pain in the current study. Nevertheless, neuraxial blockades (epidural, spinal or combined spinal and epidural analgesia) represent the most effective pain relief during labor contraction pain. In observational cohort analyses like this, epidural will always be linked to complicated births since parturient with complicated birth more often need effective pain relief.

#### 4.6 The complex nature of labor pain

Psychosocial factors have an impact on maternal satisfaction. However, characteristics of the analgesia, including its efficacy and its adverse effects, as well as factors related to the pregnancy, the delivery, and the new-born baby might all affect maternal satisfaction and pain relief during labor (53). Labor pain experience is a difficult clinical outcome to evaluate; more difficult than pain after caesarean delivery (54), in which the prediction models are far more promising. Delivery of a baby is an unpredictable event and our ability to foresee intra-partum complications is poor. Birth experience will be affected by many of these factors and represents the major summarized outcome measure reported by the laboring woman. Development of pre-labor psychological tests to identify high risk women, and corresponding individualized care, appears to be an important way to move forward in addressing this public health issue of postpartum pain and depression (55).

## 4.7 Limitations:

Even if the analyses in the current study are based on a large number of individuals, missing data limits the conclusions to some degree. We have handled missing data through advanced statistical procedures to reduce bias. As data were missing at random we performed multiple imputations. The results were similar without adjusting for missing, thus increasing the reliability of the interpretation.

We chose to set the cutoff to 10 or more on the EDPS as an indication of postpartum depression. Other studies have used different cutoffs (e.g. 37), which could influence incidence rates, but we chose to be consistent with the Norwegian validation study and recommendation derived from that (27).

Intra-partum pain scores in the sample were skewed to the right as most women rated their pain as NRS 9 or 10. This may have complicated the analyses of association with pain and depression eight weeks later. A dataset with repeated intra-partum pain ratings would be more precise, and desirable, but less likely to obtain in such a large sample. Moreover, the delay in utilization of epidural analgesia may have led to increased pain intensity experienced across the board and may thus have skewed the pain data. All EDA was performed by trained anesthesiologist at a university hospital with approximately 5 000 annual deliveries. Even if we expect high rates of success, the rate of insufficient pain relief and unsuccessful epidurals is, however, not reported. Finally, the birth cohort only included Norwegian-speaking women, which limits the generalizability of the results somewhat.

## 5 CONCLUSIONS

In this study, intrapartum pain intensity were not associated with postpartum depression or persistent pain eight weeks after delivery. Intrapartum birth experience was significantly associated with postpartum depression, but not persistent pain, eight weeks after delivery. A history of pain and depression before pregnancy were both strongly and significantly associated with pain and depression eight weeks after delivery, which implies the need to screen for these conditions in pregnant women and consider preventive measures.

## 6 ABBREVIATIONS

EPDS: The Edinburgh Postnatal Depression Scale

EDA: epidural analgesia

## 7 DECLARATIONS

### 7.1 Ethics approval and consent to participate

Written informed consent was obtained from all participants, and all women invited to participate in the ABC study were informed that participation was voluntary. The study was approved by Regional Committee for Ethics in Medical Research in Norway, approval number S-08013a. The study is performed and reported according to STROBE guidelines (24).

### 7.2 Consent for publication

Not applicable.

### 7.3 Availability of data and material

The dataset analysed during the current study is not publicly available due to data privacy restrictions and ethical restrictions established by the Norwegian Regional Committee for Ethics in Medical Research. Data are, however, available through application to the ABC study. All enquiries about access to data should be sent to the ABC steering group,



attention: Nina.odegard@ahus.no. All requests to access personal data will be handled in accordance with the procedures by the Ethics Committee.

## 7.4 Competing interests

The authors declare that they have no competing interests related to the work presented.

## 7.5 Funding

While the original study was funded by the Norwegian Research Council (project number 191098), no funding was received for this particular study.

## 7.6 Authors' contributions

All authors have read and approved the paper. The ABC study was designed by ME-G, while the current study was proposed by LAR and SER; TBS was responsible for the data collection in the ABC study, LAR and SER designed and put together the first draft, while MT and SER carried out the statistical analysis; all authors contributed towards writing and completing the manuscript and data interpretation.

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## TABLES

**Tab. 1:** Sociodemographic, psychological and clinical characteristics of the study population

Characteristics	M (SD)
Mother's age at time of delivery	30.7 (4.93)
Duration of delivery (hours)	6.8 (4.97)
Labor pain intensity (0-10)	8.3 (1.99)
Birth experience (0-10) <sup>1</sup>	2.8 (2.48)
Opening when given EDA (cm)	6.5 (2.53)
	% (n)
Employed at the start of pregnancy	90% (n=3742)
Persistent pain before pregnancy	11% (n=377)
Depression before pregnancy	36% (n=1223)
Vaginal delivery (yes)	85% (n=3728)
Epidural analgesia (yes)	26% (n=1138)
First childbirth (yes)	49% (n=1726)
Gave birth to twins (yes)	1.3% (n=58)

<sup>1</sup> Lower score means more positive birth experience

**Tab. 2a:** Univariate and multivariate associations (odds ratios) between labor pain (measured within 48 hours after delivery) and persistent postpartum pain, with missing data imputed

	Univariate associations OR (95% CI) p-value	Multivariate model <sup>1</sup> OR (95% CI) p-value	Multivariate model <sup>2</sup> OR (95% CI) p-value
Labor pain intensity (0-10)	1.00 (0.95-1.05) 0.93	1.01 (0.95-1.07) 0.78	1.03 (0.92-1.15) 0.56
Persistent pain before pregnancy (yes/no)	4.11 (3.13-5.39) <0.01	4.12 (3.14-5.42) <0.01	3.70 (2.71-5.04) <0.01
Depression before pregnancy (yes/no)	2.40 (1.97-2.93) <0.01		2.31 (1.85-2.88) <0.01
First childbirth (yes/no)	0.89 (0.73-1.07) 0.20		1.02 (0.81-1.29) 0.88
Delivery (cesarean)	1.58 (1.23-2.03) <0.01		1.75 (1.14-2.69) 0.01
Duration of delivery (hours)	1.02 (1.00-1.04) 0.02		1.01 (0.98-1.03) 0.69
Tear (0-6)	1.02 (0.93-1.12) 0.65		1.10 (0.99-1.23) 0.09
EDA (yes/no)	1.56 (1.26-1.92) <0.01		1.47 (1.12-1.91) <0.01

<sup>1</sup> Adjusted for persistent pain before pregnancy

<sup>2</sup> Adjusted for persistent pain and depression before pregnancy and clinical data (first childbirth, vaginal delivery, duration of delivery, vaginal tears, EDA)

**Tab. 2b:** Univariate and multivariate associations (odds ratios) between birth experience (measured within 48 hours after delivery) and persistent postpartum pain, with missing data imputed

	Univariate associations OR (95% CI) p-value	Multivariate model <sup>1</sup> OR (95% CI) p-value	Multivariate model <sup>2</sup> OR (95% CI) p-value
Birth experience overall (0-10) <sup>3</sup>	1.04 (0.96-1.11) 0.31	1.04 (0.98-1.12) 0.21	1.01 (0.94-1.10) 0.73

	<b>Univariate associations OR (95% CI) p-value</b>	<b>Multivariate model<sup>1</sup> OR (95% CI) p-value</b>	<b>Multivariate model<sup>2</sup> OR (95% CI) p-value</b>
Persistent pain before pregnancy (yes/no)	4.11 (3.13-5.39) <0.01	4.13 (3.14-5.43) <0.01	3.69 (2.71-5.03) <0.01
Depression before pregnancy (yes/no)	2.40 (1.97-2.93) <0.01		2.30 (1.84-2.87) <0.01
First childbirth (yes/no)	0.89 (0.73-1.07) 0.20		1.03 (0.81-1.30) 0.83
Delivery (cesarean)	1.58 (1.23-2.03) <0.01		1.65 (1.09-2.50) 0.02
Duration of delivery (hours)	1.02 (1.00-1.04) 0.02		1.01 (0.98-1.03) 0.69
Tear (0-6)	1.02 (0.93-1.12) 0.65		1.10 (0.99-1.23) 0.09
EDA (yes/no)	1.56 (1.26-1.92) <0.01		1.47 (1.13-1.92) <0.01

<sup>1</sup>Adjusted for persistent pain before pregnancy

<sup>2</sup> Adjusted for persistent pain and depression before pregnancy and clinical data (first childbirth, vaginal delivery, duration of delivery, vaginal tears, EDA)

<sup>3</sup>Lower score means more positive birth experience

**Tab. 3a:** Univariate and multivariate associations (odds ratios) between labor pain (measured within 48 hours after delivery) and postpartum depression, adjusted for missing data

	<b>Univariate associations OR (95% CI) p-value</b>	<b>Multivariate model<sup>1</sup> OR (95% CI) p-value</b>	<b>Multivariate model<sup>2</sup> OR (95% CI) p-value</b>
Labor pain intensity (0-10)	0.97 (0.90-1.05) 0.41	0.98 (0.91-1.07) 0.68	0.98 (0.85-1.12) 0.73
Depression before pregnancy (yes/no)	4.46 (3.39-5.87) <0.01	4.45 (3.38-5.86) <0.01	4.11 (3.06-5.54) <0.01
Persistent pain before pregnancy (yes/no)	2.35 (1.69-3.28) <0.01		1.99 (1.36-2.90) <0.01
First childbirth (yes/no)	0.85 (0.66-1.10) 0.22		0.93 (0.68-1.28) 0.66
Delivery (cesarean)	1.19 (0.84-1.69) 0.32		0.95 (0.51-1.78) 0.87
Duration of delivery (hours)	1.01 (0.98-1.04) 0.44		1.01 (0.98-1.04) 0.58
Tear (0-6)	1.00 (0.88-1.14) 0.97		1.07 (0.93-1.25) 0.34
EDA (yes/no)	1.06 (0.79-1.43) 0.68		1.02 (0.72-1.46) 0.90

<sup>1</sup>Adjusted for depression before pregnancy

<sup>2</sup>Adjusted for depression and pain before pregnancy and clinical characteristics (first childbirth, vaginal delivery, vaginal tears, EDA)

**Tab. 3b:** Univariate and multivariate associations (odds ratios) between birth experience (measured within 48 hours after delivery) and postpartum depression, adjusted for missing data

	<b>Univariate associations OR (95% CI) p-value</b>	<b>Multivariate model<sup>1</sup> OR (95% CI) p-value</b>	<b>Multivariate model<sup>2</sup> OR (95% CI) p-value</b>
Birth experience overall (0-10)	1.15 (1.04-1.27) <0.01	1.13 (1.02-1.26) 0.03	1.16 (1.04-1.29) 0.01
Depression before pregnancy (yes/no)	4.46 (3.39-5.87) <0.01	4.34 (3.28-5.74) <0.01	3.95 (2.92-5.34) <0.01
Persistent pain before pregnancy (yes/no)	2.35 (1.69-3.28) <0.01		2.03 (1.37-3.01) <0.01
First childbirth (yes/no)	0.85 (0.66-1.10) 0.22		0.94 (0.68-1.31) 0.72
Delivery (cesarean)	1.19 (0.84-1.69) 0.32		0.83 (0.45-1.53) 0.55
Duration of delivery (hours)	1.01 (0.98-1.04) 0.44		1.00 (0.97-1.03) 0.94

	<b>Univariate associations</b>	<b>Multivariate model<sup>1</sup></b>	<b>Multivariate model<sup>2</sup></b>
	<b>OR (95% CI) p-value</b>	<b>OR (95% CI) p-value</b>	<b>OR (95% CI) p-value</b>
Tear (0-6)	1.00 (0.88-1.14) 0.97		1.05 (0.90-1.22) 0.55
EDA (yes/no)	1.06 (0.79-1.43) 0.68		0.94 (0.65-1.35) 0.73

<sup>1</sup>Adjusted for depression before pregnancy

<sup>2</sup> Adjusted for depression and pain before pregnancy and clinical characteristics (first childbirth, vaginal delivery, duration of delivery, vaginal tears, EDA)

## Legends to figures

Figure 1

Study flowchart showing number of included women, analyzed and excluded or lost to follow-up.

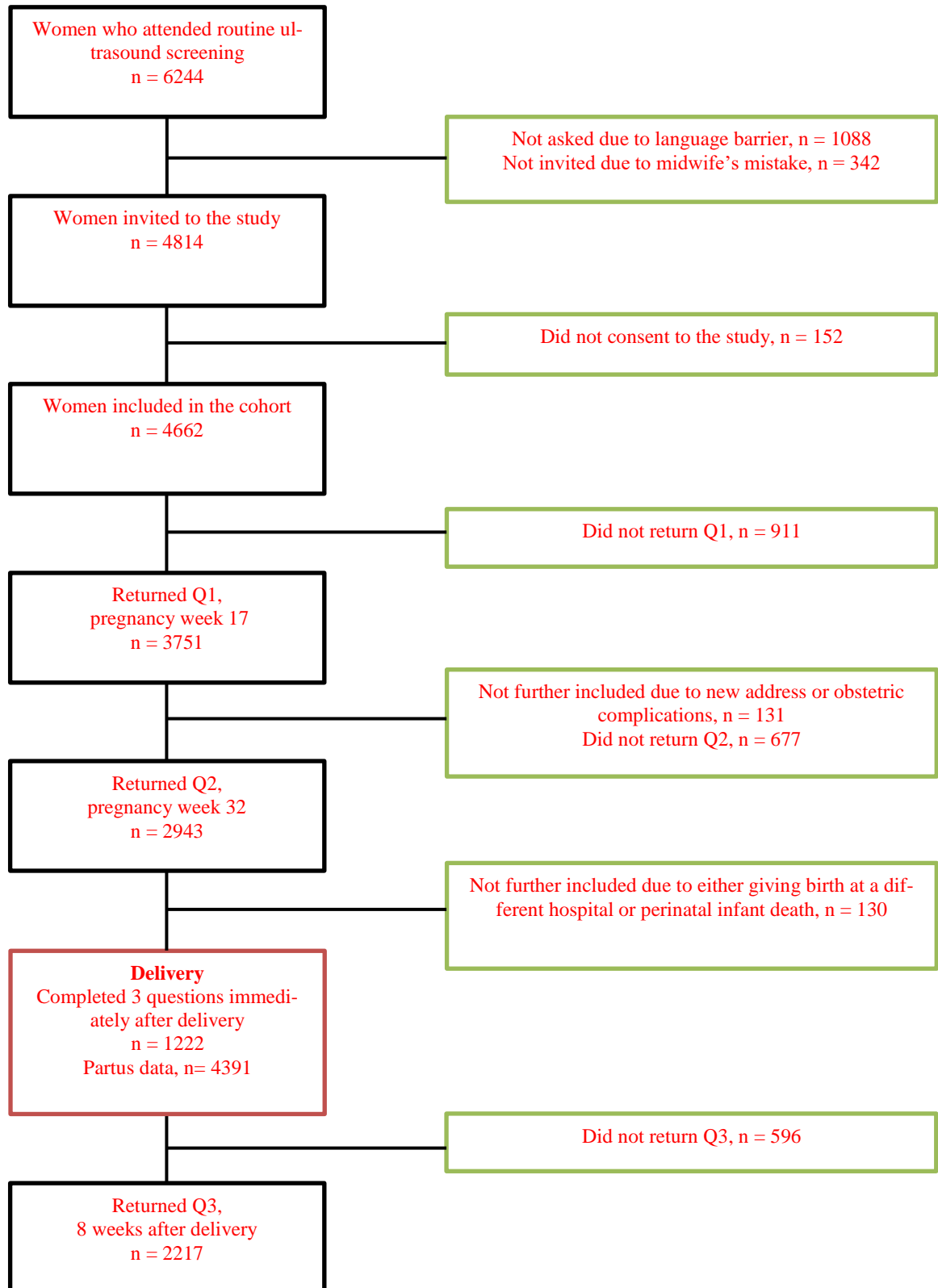


Figure 2  
Pain intensity during labor. Numeric Rating Scale (0-10) scored after delivery (n=1221).



### Pain intensity during vaginal delivery

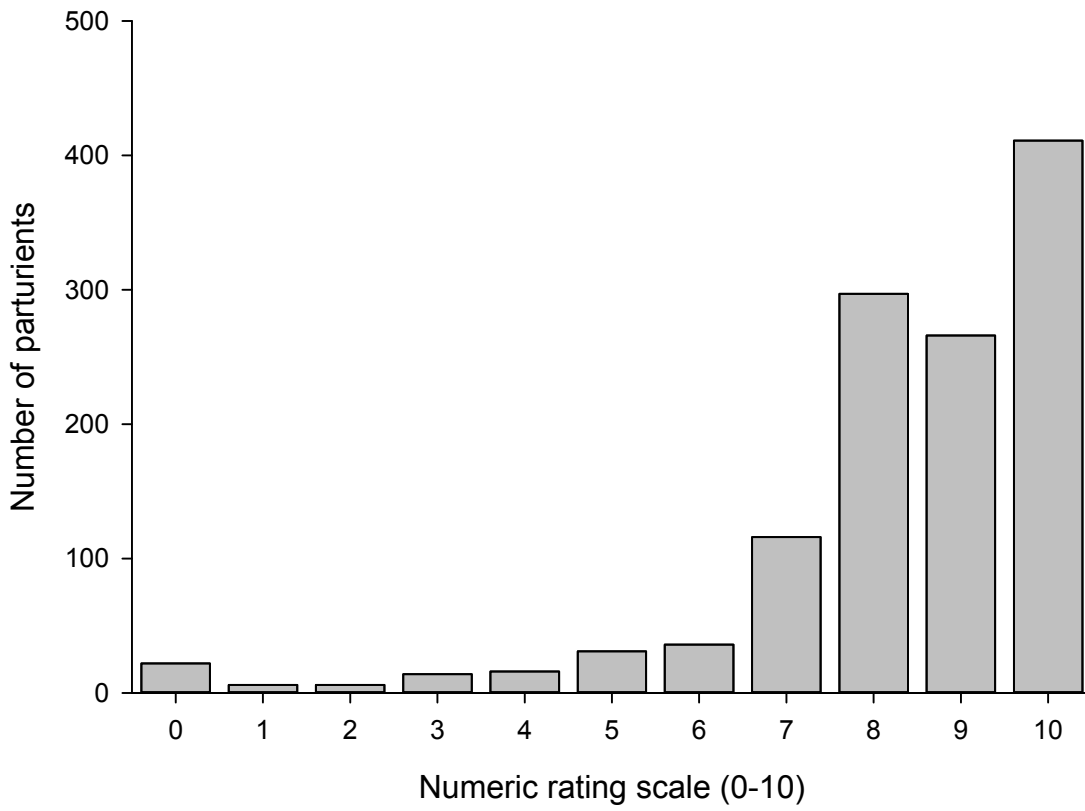


Figure 3

Binned scatterplot of pain intensity during labor (Numeric Rating Scale 0-10) against birth experience (Numeric Rating Scale 0-10, 0 is best, 10 is worst experience) scored after delivery (n=1221).

Figure 3

