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Predictors of Headache Before, During, and After Pregnancy: A Cohort Study

Dana P. Turner, MSPH¹, Todd A. Smitherman, PhD², James C. Eisenach, MD^{1,*}, Donald B. Penzien, PhD³, and Timothy T. Houle, PhD¹

¹Wake Forest School of Medicine, Department of Anesthesiology, Winston-Salem, NC, USA

²University of Mississippi, Department of Psychology, Oxford, MS, USA

³University of Mississippi Medical Center, Department of Psychiatry and Human Behavior, Head Pain Center, Jackson, MS, USA

Abstract

Objective—The present study endeavored to identify predictors of headache during pregnancy, shortly after delivery, and at 8-week follow-up.

Background—Many women suffer from headaches during pregnancy and the postpartum period. However, little is known about factors that predict headache surrounding childbirth.

Methods—Secondary analysis of longitudinal cohort study of 2434 parturients hospitalized for cesarean or vaginal delivery in four university hospitals in the United States and Europe. Data were gathered from interviews and review of medical records shortly after delivery; 972 of the women were contacted 8 weeks later to assess persistent headache. The primary outcome measures were experiencing headache during pregnancy, headache within 72 hours after delivery, and headache at 8 weeks after delivery.

Results—Of the parturients, 10% experienced headache during pregnancy, 3.7% within 72 hours after delivery, and 3.6% at 8 weeks post delivery. Compared to those without a history of headache, a history of headache prior to pregnancy was the strongest predictor of headache during pregnancy (9.8% versus 23.5%; RR 2.4; 95% CI: 1.4 to 4.0). Experiencing headache during pregnancy (adjusted HR 3.8; 95% CI: 2.4 to 6.2) and receiving needle-based regional anesthesia for pain treatment (adjusted HR 2.2; 95% CI: 1.1 to 4.5) were independently associated with headache within 72 hours after delivery with event rates of 11.1% and 10.5%, respectively. Compared to those without such a history, headache before pregnancy was significantly associated with experiencing headache 8 weeks after delivery (4.0% versus 23.8%; RR = 6.0; 95% CI: 2.0 to 8.0), but headache during pregnancy or shortly after delivery was not. Several other psychosocial predictors (e.g., somatization, smoking before pregnancy) were statistically associated with at least one headache outcome.

Corresponding Author: Dana P. Turner, Wake Forest School of Medicine –Anesthesiology, Medical Center Boulevard Winston-Salem North Carolina 27157 United States T: 336-716-5899 F: 336-716-5882, daturner@wfubmc.edu.

*On behalf of the Pain After Delivery investigators.

Conflicts of Interest:

Dana P. Turner: Ms. Turner receives research support from Merck.

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James C. Eisenach: Dr. Eisenach is a consultant with Medtronic, Adynxx, Vertex, and Glaxo-Smith-Kline and receives research support from King Pharmaceuticals.

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Conclusions—A history of headache prior to pregnancy is a strong predictor of headache during and after pregnancy, the latter independent of but compounded by spinal injection. Physicians should attend to prior headache history when making decisions about pain management during and after childbirth. As the lack of formal ICHD-II headache diagnoses is a limitation of this study, future longitudinal studies should replicate the present design while including headache subtyping consistent with ICHD-II nosology.

Keywords

Pregnancy; migraine; spinal anesthesia

Migraine and other headaches disproportionately affect women of childbearing age.¹ Dramatic physiologic fluctuations in circulating estrogen concentrations are associated in some women with headache frequency and severity.² Estrogen concentrations rise rapidly during pregnancy, coinciding with changes in headache patterns.³ Most women (40–80%) with preexisting migraine will experience resolution or improvement during pregnancy^{4–9} with most improvement occurring in patients without aura symptoms.¹⁰ However, a significant minority of parturients will evidence worsening or no improvement in headache, and 2–7% will experience headache *de novo* during pregnancy.^{6,11}

Although preexisting headache often improves during pregnancy, approximately one-third of mothers experience postpartum headache within the first week after delivery,^{9, 12} making headache one of the three most common reasons for acute care visits during the puerperium.¹³ The large majority of postpartum headaches are recurrences of preexisting primary headache disorders, which recur within a month after delivery in 55% of prior migraineurs.⁹ Prior headache history, dural puncture, increasing age, multiparity, and shorter length of second-stage pushing have been identified as potential risk factors for postpartum headache shortly after delivery,¹² though studies are needed of large and geographically diverse samples that assess headache at multiple time points surrounding childbirth and that assess women at multiple time points surrounding childbirth.

With over 4 million annual live births in the United States alone, poorly-controlled headache during or subsequent to pregnancy carries significant public health consequences, foremost among them increased risk of chronic pain, prolonged hospitalization and related costs, delayed resumption of usual activities, and potential impairments in bonding with and care of the newborn.^{14,15} The objective of the present study was to examine predictors of headache during pregnancy, after delivery, and at 8-week follow-up. We hypothesized that previous headache history would be related to headache events during pregnancy and after delivery.

Methods

A secondary analysis was performed on data from the longitudinal cohort Pain After Delivery (PAD) study.¹⁶ Institutional Review Board approval was obtained for the original study, and the present secondary analysis was considered exempt. Parturients were recruited from September 2004 to December 2005 at four university hospitals (Winston-Salem, NC, USA; New York, NY, USA; Geneva, Switzerland; Brussels, Belgium) and provided written informed consent. All parturients hospitalized for cesarean or vaginal delivery at each hospital were invited to participate, except during weekends and holidays when research personnel were unavailable. These women were queried within 72 hours after delivery about acute pain after delivery, pain history before and during pregnancy, other medical history, and demographic information (Entrance Questionnaire, Appendix). At the two U.S. hospitals, post-delivery questions were administered by research personnel in the form of a

scripted interview; patients at the European sites completed the questionnaire in written format. Patient medical records were also reviewed by on-site research personnel, who directly transcribed data pertaining to age, body mass index, and gestational age. Women from the two U.S. hospitals were contacted 8 weeks later and interviewed by telephone using a computer-assisted scripted interview that inquired about persistent pain.

Headache prior to pregnancy was identified from several responses to the Entrance Questionnaire. Women who either indicated they had “chronic pain that started before this pregnancy” (question 4) or were “seeing a doctor regularly for any medical problems in the year before your pregnancy” (question 8) and listed head, headache, or migraine as the pain location or condition (questions 4a, 8b, and 8b1) were considered to have headache prior to pregnancy. Women who answered “yes” to “taking daily pain medications before this pregnancy” (question 5) or “taking any medications regularly (daily or > 3 days a week) during the year before pregnancy” (question 9) and listed medications exclusively used for migraine (e.g., a triptan) (questions 5a, 9a, and 9b) also were considered to have headache prior to pregnancy.

The principal outcome measures were headache during pregnancy, headache within 72 hours after delivery, and headache at 8 weeks after delivery. Headache during pregnancy was identified from questions 15 and 16 of the Entrance Questionnaire. Women were considered to have headache during pregnancy if they identified “headache” as the location of pain during pregnancy (question 15d) or reported taking regular medications during pregnancy for headache or migraine (questions 16a and 16b). Headache within 72 hours of delivery was identified from endorsements of “headache” as the site of current pain subsequent to delivery (question 24f). Women were considered to have headache at 8 weeks after delivery if they identified headache or migraine as an ongoing health problem or were currently taking a headache or migraine medication at the 8-week follow-up phone interview.

In addition to headache variables, the Entrance Questionnaire assessed many demographic and delivery characteristics. This information included self-reported general state of health, presence of chronic pain before pregnancy, use of daily pain medications before pregnancy, presence of chronic pain in family members, level of menstrual pain, regular doctor visits for medical problems before pregnancy, use of medications regularly (> 3 times per week) before pregnancy, smoking more than 1 pack of cigarettes a week in the year before pregnancy, level of alcohol consumption in the year before pregnancy, pain from previous operations, pain level during pregnancy, regular medications during pregnancy, and prolonged pain after previous birth. The questionnaire also included a somatization scale (questions 3a-j).¹⁷ Data on receipt of regional anesthesia injections were obtained from a separate Delivery Information Questionnaire (as described in Eisenach et al., 2008¹⁶).

Statistical analyses

This is a secondary analysis of the Pain After Delivery (PAD) study, and a description of the primary analyses, including the original statistical power considerations, has been reported previously.¹⁶ Due to the secondary nature of this analysis (i.e., the study was not originally powered to examine these hypotheses), care was taken to report and interpret point estimates of effect size with 95% confidence intervals. Descriptive statistics are presented as mean (SD) for normally distributed scaled data and frequency counts with percentages for categorical data.

To examine the associations between patient characteristics and the presence of headache during pregnancy, a multivariable logistic regression model was created. The model was specified based on forced entry of this set of a priori selected predictors. The model

controlled for study site, and care was taken to consider the correlations among predictors prior to analysis (i.e., none of the predictors were so highly correlated as to present estimation problems in the analysis). To predict the presence of headache within 72 hours after delivery, a multivariable Cox proportional-hazards model was created. Based on the modest number of parturients who experienced headache after delivery ($n = 92$), care was taken to specify a model that employed a suitably limited number of predictors (to avoid overfitting the data). The proportional-hazards assumption was tested and satisfied prior to interpretation of the model.

To express the relative risks of the various predictors, odds ratios (logistic regression model), hazard ratios (Cox proportional-hazards model), and risk ratios all with respective 95% confidence intervals are reported. The RR was chosen to express the relative risk of experiencing headache at one measurement occasion conditional on previous occasions because of the relative frequency of the observed event rates (odds ratios and risk ratios are only similar for rare events) and ease of interpretation that this metric provides. For example, a RR of 3.0 indicates that experiencing a headache is three times more likely in one group versus another. All analyses were conducted using SAS 9.2 (SAS, Inc. Cary, NC). Where appropriate, all hypotheses are two-tailed with $p < 0.05$.

Results

2434 deliveries were carried out during the study period. The greatest number of participants ($n = 876$) was recruited from Winston-Salem, NC. Demographic and delivery characteristics of the four sites were similar in most cases (Table 1).

Headache before pregnancy

The percentage of women from all sites who experienced headache before pregnancy was 6.3% (154/2434) (Table 2). The percentage of women who explicitly reported experiencing migraine as a type of headache was 3.6%. However, some variation in reporting of chronic pain and headache prior to pregnancy was observed, and this resulted in post hoc revisions to the analytical plan. Specifically, women from Brussels reported a higher rate of headache before pregnancy than women at the other sites (20.2% vs. 2.3–3.2%) (Figure 1; Table 2). This site difference was taken into account during subsequent analyses: Headache history as a univariate predictor of headache during or after pregnancy was based only on data from the New York, Winston-Salem, and Geneva sites; for all other analyses all participants were used.

Headache during pregnancy

Of the parturients, 10% (244/2434) experienced headache during pregnancy, with similar rates across sites (8.6%–12.9%; Table 2). A regression model was conducted using all of the predictors in Table 3. Compared to those without a history of headache, experiencing headache prior to pregnancy was associated with an increased risk of experiencing headache during pregnancy (9.8% versus 23.5%; RR 2.4; 95% CI: 1.4 to 4.0; Figure 2). Having a history of chronic pain (adjusted OR 2.18; 95% CI: 1.42 to 3.37), smoking prior to pregnancy (adjusted OR 1.50; 95% CI: 1.05 to 2.13), and prolonged pain after previous birth (adjusted OR 1.42; 95% CI: 1.04 to 1.94) were also associated with increased odds of experiencing headache during pregnancy (Table 3). Other patient history and demographic variables were not associated with increased risk for headache during pregnancy.

Headache 72 hours after delivery

Of the women, 3.7% (91/2434) experienced a headache within 72 hours after delivery (Table 2), with generally similar rates across sites (2.5%–5.4%). A Cox proportional-hazards

model was conducted using all of the predictors in Table 4. Of the variables pertaining to prior headache history and analgesic use surrounding pregnancy, experiencing headache during pregnancy (adjusted HR 3.83; 95% CI: 2.37 to 6.18) and receiving regional anesthesia injections (epidural/spinal/Combined Spinal Epidural (CSE)) (adjusted HR 2.19; 95% CI: 1.07 to 4.50) were most strongly associated with increased risk of developing headache within 72 hours after delivery (Table 4). Although an association with acetaminophen was identified (adjusted HR 1.71; 95% CI: 1.32 to 2.22), this medication often is given in response to pain and as such may not be predictive. As several of these medications are given both as a part of routine pain treatment and for additional pain relief for those in acute distress, interpretation of the model must be made with caution.

The survival curve in Figure 3 depicts the proportion of patients who remained free from headaches up to 72 hours after delivery by (a) whether or not they experienced headache during pregnancy and (b) whether or not regional anesthesia was used. Women who did not experience headache during pregnancy and did not receive regional anesthesia injections were the group most likely to be free from headache at any time during the 72 hours after delivery. Conversely, women who experienced headache during pregnancy and received regional anesthesia injections were least likely to be free from headache during the 72 hours after delivery. Headache prior to pregnancy was not associated with increased risk of headache within 72 hours after delivery.

Headache 8 weeks after delivery

Of the 972 women from the two U.S. sites who were interviewed at 8 weeks after delivery, 4.5% experienced headache after delivery (Table 2). Compared to those without such a history, having headache before pregnancy was significantly associated with experiencing headache 8 weeks after delivery (4.0% versus 23.8%; RR 6.0; 95% CI: 2.0 to 8.0). However, neither experiencing headache during pregnancy (RR 0.82; 95% CI: 0.04 to 1.23) or experiencing headache within 72 hours of delivery (RR 0.66; 95% CI: 0.003 to 1.5) were associated with increased risk of headache at 8 weeks post-delivery (Figure 2).

Discussion

Headache during and after pregnancy is a common occurrence resulting in significant public health consequences and resulting impairments in childcare at a time that is integral to maternal bonding. Despite its prevalence, however, headache surrounding pregnancy remains poorly understood, and only recently have researchers attempted to identify potentially modifiable predictors of headache surrounding pregnancy. Limited cross-sectional data have implicated previous headache history, dural puncture, multiparity, and increasing age as risk factors associated with headache in the postpartum period.^{7, 12, 18}

The present study extended prior research to a very large and geographically diverse sample of 2,434 women from two hospitals in the U.S. and two in Europe. Most notably, we found that prior headache history consistently emerged as a strong predictor of headache surrounding pregnancy. At each of the three time points (during pregnancy, within 72 hours after delivery, and at 8 weeks after delivery), a history of headache was more strongly associated with current headache than were multiple other health, demographic, and psychosocial variables. At the initial and last time point, prediction of headache was afforded most strongly by a prior history of headache *predating pregnancy*, whereas headache shortly after pregnancy was most strongly predicted by a prior history of headache *during pregnancy*.

Specifically, headache during pregnancy and at 8 weeks after delivery were strongly predicted by a history of headache prior to pregnancy, with risk increasing nearly 2.5 times

for headache during pregnancy and 6 times for headache at 8 weeks after delivery. These findings are consistent with the notion that many headaches during pregnancy and postpartum represent ongoing primary headache disorders.⁹ Headache within 72 hours after delivery was predicted very strongly by a history of headache during pregnancy (but not by headache prior to pregnancy) and by epidural/spinal/CSE injection, either for labor analgesia or cesarean delivery anesthesia. Patients with headache during pregnancy were nearly 4 times more likely to experience headache shortly after delivery, and those receiving regional anesthesia were 3 times more likely to experience headache. Participants with a history of headache during pregnancy and receiving regional anesthesia were far more likely than any other participants to experience a headache within 72 hours after delivery, confirming that these variables have independent but synergistic effects.

Inadvertent dural puncture with an epidural needle carries a high risk of headache^{12,19} due to leakage of cerebrospinal fluid into the epidural space through the large hole produced by the epidural needle.²⁰ We did not have a clear representation of which women received spinal insertions versus epidurals for vaginal deliveries, and therefore women who had spinal needle insertion in labor are not identified in this study. As such, we cannot determine the precise rate or risk of inadvertent dural puncture specifically as contributing to our findings regarding headache related to regional anesthesia. However, the majority of caesarean regional anesthesia in this study was spinal-based (62% spinal/CSE), and thus it is likely that the spinal route of administration strongly contributes to these findings. In contrast to dural puncture with an epidural needle, however, a dural puncture made with a pencil-pointed 25- or 27-gauge spinal needle, as used in these women for cesarean delivery, results in a smaller hole in the dura and a much lower incidence (1–2%) of headache after the procedure. The finding that headache history and needle-based regional anesthesia confer independent and synergistic effects can be used to inform physician practice, treatment choices, and regularity of monitoring following discharge. Because headache during the puerperium period is of central importance to predicting subsequent headache after delivery, identification and management of headache during pregnancy is essential. The relative benefits and headache risks, among others, of spinal anesthesia should be carefully weighed in a patient with a history of severe and frequent headaches. Women routinely are instructed to notify health care personnel of the presence of headache within 72 hours of delivery, and most anesthesiologists inject autologous blood into the epidural space (epidural blood patch) to treat this headache prior to patient discharge from the hospital.

Limitations and Future Directions

Strengths of this study include its large sample of participants from three countries and four research sites, multivariate data analytic strategy to adjust for other predictors of headache, and assessment of headache symptoms at multiple points surrounding pregnancy and childbirth. The assessment of numerous pain, general health, demographic, and psychosocial variables as risk factors also is more comprehensive than previous studies on headache surrounding pregnancy. Despite its strengths, the present study has several limitations, most of which center around the means by which headache was assessed and classified. The principal limitation of this study lies in our reliance on self-reported past and current headache problems rather than assessment using formal ICHD-II diagnostic criteria.²¹ Although this limitation was dictated by the format of the Entrance Questionnaire used in the main study, it did preclude precise specification and comparisons of specific headache subtypes, and thus readers should exercise caution in extrapolating our findings as they pertain to specific headache subtypes. However, our observed rates of headache both before and after pregnancy were somewhat lower than those obtained in other studies^{1,9, 12} suggesting our participation characterization strategy did not result in overly liberal headache endorsement.

Our relatively lower rates of headache prior to pregnancy are likely a function of the fact that prior headache was defined by endorsement of “chronic” head pain, regular medical visits for headache, or regular use of headache-specific agents in the year prior to pregnancy. Higher rates of prior headache likely would have been obtained had headache symptoms specifically been assessed in a more standardized format, in which case less frequent or disabling headaches would more likely be identified. Lower rates of headache shortly after delivery may be attributable to potential sampling bias insofar as patients in extreme pain may have declined participation and patients delivering on weekends and holidays were not assessed, or to potential recall bias to the extent that assessment in the 72 hours post-delivery is a time beset with strong emotions and potential reporting inaccuracies. Higher rates of headache during this time frame might have been observed had we inquired about any headache within this 72-hour period rather than current head pain and included more frequent periodic assessment instead of two discrete follow-up intervals (72 hours and 8 weeks post-delivery).

More minor limitations surround the loss of the European participants at the 8-week follow-up and the different formats in which participants at the U.S. versus European sites provided data for the Entrance Questionnaire (scripted interview versus self-report measure). Although patients at all sites responded to the same questions, varied administration formats and translation into French (for the European sites) may have affected participant responses. We attempted to control for observed differences in pre-pregnancy headache across sites (ie, Brussels’ participants endorsing higher prevalence of prior headache) by sub-setting the analyses pertaining to prior headache history by using data only from the Winston-Salem, New York, and Geneva sites. In light of these limitations, replication with similarly large samples using ICHD-II nosology and longer follow-up intervals is warranted. Future studies of headache patterns during and after pregnancy also should focus on further disentangling the relative contributions of prior headache history and anesthesia procedures, with comparison between spinal and epidural routes of administration for identification of suspected dural puncture. Such studies should focus on following pregnant women longitudinally and further clarifying the clinical implications of these and other previously-established risk factors.

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Appendix: Entrance Questionnaire

PAD STUDY ENTRANCE QUESTIONNAIRE

- a Patient ID:
- b Patient Name:
- c Phone Number for follow-up calls:
- d Date of delivery:
 ____/____/____
 MM DD YY
- e Time since delivery:
☐ < 24 hours ☐ 24–48 hours ☐ 48–72 hours
- 1 How would you rate your delivery experience?
☐ extremely satisfactory
☐ very satisfactory
☐ satisfactory

- ☐unsatisfactory
- ☐extremely unsatisfactory

2 What is your general state of health?

- ☐excellent
- ☐very good
- ☐fair
- ☐poor

3 Check the description that most corresponds to how the following statements describe you:

	Not at all true	A little bit true	Moderately true	Quite a bit true	Extremely true
3a. I can't stand smoke, smog, or pollutants in the air	☐	☐	☐	☐	☐
3b. I am often aware of various things happening within my body	☐	☐	☐	☐	☐
3c. When I bruise myself, it stays noticeable for a long time	☐	☐	☐	☐	☐
3d. I sometimes can feel the blood flowing in my body	☐	☐	☐	☐	☐
3e. Sudden loud noises really bother me	☐	☐	☐	☐	☐
3f. I can sometimes hear my pulse or my heartbeat throbbing in my ear	☐	☐	☐	☐	☐
3g. I hate to be too hot or too cold	☐	☐	☐	☐	☐
3h. I am quick to sense the hunger contractions in my stomach	☐	☐	☐	☐	☐
3i. Even something minor, like an insect bite or a splinter, really bothers me	☐	☐	☐	☐	☐
3j. I can't stand pain	☐	☐	☐	☐	☐

4 Have you had chronic pain that started before this pregnancy?

- ☐YES
- ☐NO

4a

If yes, please describe where your pain is and whether it is a specific pain condition:

5 Were you taking daily pain medications before this pregnancy?

- ☐YES
- ☐NO

5aIf YES, please list the medicines and amounts:

- 6** Do any members of your family (parents, brother or sister, uncle, aunt or close cousins) have a problem with chronic pain that causes them to see a doctor regularly?

☐ YES☐ NO

If YES,

6a

Relation: _____

6b

Condition name (if known): _____

- 7** Do you usually have much pain with your menstrual bleeding?

☐ NO☐ YES, but not usually needing treatment with medication☐ YES, moderate, requiring medication some months☐ YES, severe, usually requiring medication**7a**

If YES, have you seen a physician for evaluation of the problem?

☐ YES☐ NO

- 8** Were you seeing a doctor regularly for any medical problems in the year before your pregnancy?

☐ YES☐ NO

If YES, the reason I was seeing the doctor was (check all that apply)

8a ☐ chronic medical condition (diabetes, high blood pressure, asthma, etc.)

8a1 condition: _____**8b** ☐ pain**8b1** location of pain: _____**8c** ☐ urinary problems**8d** ☐ infection**8e** ☐ depression/anxiety**8f** ☐ other**8f1** describe other: _____

- 9** Were you taking any medications regularly (daily or > 3 times a week) during the year before your pregnancy?

☐ YES

☐ NO

If YES,

9a The name of the medication I was taking was/is:

9b The condition that the medication was treating was/is:

9 additional. Have you ever received treatment for any of the following infections? (check all that apply)

9.d. Bladder/lower urinary tract infection ☐

9.e. Kidney infection ☐

9.f. Vaginal/other gynecological infection ☐

10 In the year before your pregnancy, did you smoke cigarettes (more than 1 pack per week)

☐ YES

☐ NO

11 In the year before your pregnancy, did you drink alcohol (beer, wine, or “hard” liquor)

☐ NONE

☐ YES, 1–3 drinks/week

☐ YES, 4–6 drinks/week

☐ YES, > 6–10 drinks/week (about 1 drink/day)

☐ YES, more than 2 drinks/day

12 Have you had any problems after any previous **operations**? (check all that apply)

12a ☐ wound infection

12b ☐ other infection

12c ☐ prolonged period of pain (more than 2 or 3 weeks)

12d ☐ re-operation (need for second operation)

12e ☐ other

12e1 describe other _____

12f ☐ had surgery, no problems afterward

12g ☐ never had surgery before

12h If you had a problem noted above, type of operation

13 Did you have any problems after the **birth of any previous baby**? (check all that apply)

13a ☐ infection (non-urinary)

13b ☐ prolonged period of pain (more than 2 or 3 weeks)

13c ☐ urinary problems, including urinary infections

13d ☐ other

13d1 describe other _____

13e ☐ this is my first baby

14 **During** your pregnancy, did you have any significant problem with pain?

☐ NO

☐ YES, mild

☐ YES, moderate

☐ YES, severe

15 Where did you have pain during your pregnancy? (check all that apply)

15a ☐ Upper Back and/or neck

15b ☐ Lower Back

15c ☐ Legs (sciatica)

15d ☐ Headache

15e ☐ Other

15e1 describe other _____

16 Did you take any medications regularly (daily or more than 3 times a week for several weeks) during your pregnancy?

☐ YES

☐ NO

☐ If YES,

16a The medication I was taking was/is:

16b The condition that the medication was treating was/is:

17 How would you rate the treatment of your pain during labor and delivery?

☐ extremely satisfactory

☐ very satisfactory

☐ satisfactory

☐ unsatisfactory

☐ extremely unsatisfactory

☐ **did not labor (cesarean section)**

18 How would you rate your anesthesia and treatment of any pain during cesarean section?

☐ extremely satisfactory

☐ very satisfactory

- ☐satisfactory
- ☐unsatisfactory
- ☐extremely unsatisfactory
- ☐**did not have a cesarean section**

19 How would you rate the treatment of your pain **SINCE** your delivery or cesarean section?

- ☐extremely satisfactory
- ☐very satisfactory
- ☐satisfactory
- ☐unsatisfactory
- ☐extremely unsatisfactory

20 Please rate your pain **on the average during the past day** on a scale of 0 to 10, where 0 equals no pain at all, and 10 equals the worst pain you can imagine.

0 1 2 3 4 5 6 7 8 9 10

21 Please rate your pain **at its worst during the past day** on a scale of 0 to 10, where 0 equals no pain at all, and 10 equals the worst pain you can imagine.

0 1 2 3 4 5 6 7 8 9 10

22 Please rate your pain **right now** on a scale of 0 to 10, where 0 equals no pain at all, and 10 equals the worst pain you can imagine.

0 1 2 3 4 5 6 7 8 9 10

23 During the past day, **pain** has interfered with your: (check all that apply)

- 23a** ☐ Walking ability
- 23b** ☐ Mood
- 23c** ☐ Sleep
- 23d** ☐ Relations with other people
- 23e** ☐ Ability to concentrate

24 Where do you have pain now? (check all that apply)

- 24a** ☐ abdomen (belly)
- 24b** ☐ upper back and/or neck
- 24c** ☐ lower back
- 24d** ☐ perineum
- 24e** ☐ C-section incision
- 24f** ☐ headache
- 24g** ☐ legs
- 24h** ☐ other
- 24h1** describe other _____

Figure 1.
Headache outcomes by time period

Figure 2.
Relationships between previous headache activity, and headache activity during pregnancy, at delivery, and at 8 weeks after delivery.

Figure 3.

Headache after delivery: survival curve depicting the proportion of patients who remained free from headache up to 72 hours past delivery by (a) whether or not they experienced a headache during pregnancy and (b) whether or not a spinal needle was used.

Table 1

Demographic and delivery characteristics by study site

	Brussels N = 510	New York N = 350	Geneva N = 698	Winston-Salem N = 876
Age	32.4 (10.2)	32.0 (6.3)	43.9 (27.4)	28.0 (7.1)
BMI	45.7 (9.4)	47.6 (12.6)	44.9 (16.9)	48.9 (17.7)
Gestational age	38.0 (3.7)	37.5 (6.7)	38.8 (4.4)	38.1 (3.7)
General Health				
Poor	2 (0.4)	1 (0.3)	5 (0.7)	1 (0.1)
Fair	72 (14.2)	17 (4.9)	101 (14.9)	56 (6.4)
Very good	269 (53.2)	141 (40.3)	344 (50.8)	451 (51.5)
Excellent	163 (32.2)	191 (54.6)	227 (33.5)	368 (42.0)
Prior chronic pain	204 (41.5)	29 (8.4)	74 (11.0)	91 (10.4)
Prior daily pain meds	45 (9.1)	8 (2.3)	37 (5.4)	23 (2.6)
Family Pain	109 (22.3)	55 (15.8)	116 (17.3)	215 (24.6)
Menstrual pain				
No	184 (37.0)	169 (48.3)	316 (46.2)	504 (57.6)
Mild	131 (26.4)	76 (21.7)	245 (35.8)	73 (8.3)
Moderate	129 (26.0)	79 (22.6)	85 (12.4)	147 (16.8)
Severe	53 (10.7)	26 (7.4)	38 (5.6)	151 (17.3)
Prior doctor regularly	89 (18.0)	75 (21.7)	229 (33.7)	156 (17.9)
Prior medications	114 (23.0)	81 (23.5)	123 (17.9)	244 (27.9)
Prior cigarettes	111 (21.9)	63 (18.2)	175 (25.4)	223 (25.5)
Prior alcohol				
None	320 (63.2)	187 (53.9)	337 (49.1)	623 (71.4)
1–3 drinks/week	155 (30.6)	121 (34.9)	237 (39.7)	197 (22.6)
4–6 drinks/week	24 (4.7)	33 (9.5)	55 (8.0)	32 (3.7)
> 6–10 drinks/week	7 (1.4)	6 (1.7)	19 (2.8)	16 (1.8)
More than 2 drinks/day	0	0	3 (0.4)	5 (0.6)
Pain from operations	11 (2.2)	13 (3.7)	11 (1.6)	11 (1.3)
Pain during pregnancy				
No	240 (47.7)	178 (51.6)	254 (36.9)	591 (67.8)
Mild	114 (22.7)	86 (24.9)	213 (30.9)	97 (11.1)
Moderate	105 (20.9)	53 (15.4)	166 (24.1)	117 (13.4)
Severe	44 (8.7)	28 (8.1)	56 (8.1)	67 (7.7)
Regular meds during pregnancy	243 (48.8)	155 (45.1)	308 (44.7)	619 (72.2)

All values are n (%) except age, BMI, and gestational age, which are mean (SD)

Table 2

Headache related outcomes by center

	Brussels N = 510 n (%)	New York N = 349 n (%)	Geneva N = 698 n (%)	Winston-Salem N = 876 n (%)	Total n (%)
Headache before pregnancy	103 (20.2%)	8 (2.3%)	22 (3.2%)	21 (2.4%)	154 (6.3%)
Migraine	56 (11.0%)	5 (1.4%)	14 (2.0%)	12 (1.4%)	87 (3.6%)
Headache during pregnancy	48 (9.4%)	45 (12.9%)	60 (8.6%)	91 (10.4%)	244 (10.0%)
Headache within 72 hours of delivery	14 (2.8%)	19 (5.4%)	36 (5.2%)	22 (2.5%)	91 (3.7%)
Headache at 8 weeks [†]	----	14 (5.3%)	----	30 (4.2%)	44 (4.5%)

[†] At 8-week follow-up total N = 972 for New York and Winston-Salem sites

Table 3

Unadjusted and adjusted predictors of experiencing headache during pregnancy

	No Headache During Pregnancy (n = 2190) median [range]; n (%)	Headache During Pregnancy (n = 244) median [range]; n (%)	Adjusted Odds Ratio [‡]	95% Confidence Interval	P value
State of Health	3 [1 to 4]	3 [2 to 4]	1.46	(1.11, 1.90)	0.006
Previous Chronic Pain	341 (15.9%)	57 (23.8%)	2.18	(1.42, 3.37)	<0.001
Daily pain meds before pregnancy	100 (4.6%)	13 (5.4%)	0.84	(0.40, 1.78)	0.66
Family members with pain	440 (20.6%)	55 (22.6%)	1.04	(0.71, 1.52)	0.85
Pain with menstrual bleeding	2 [1 to 4]	2 [1 to 4]	1.06	(0.92, 1.23)	0.43
Regular medications prior to pregnancy	503 (23.3%)	59 (24.6%)	1.11	(0.76, 1.63)	0.59
Smoke prior to pregnancy	501 (23.1%)	71 (29.2%)	1.50	(1.05, 2.13)	0.025
Alcohol use	1 [1 to 5]	1 [1 to 4]	0.96	(0.77, 1.20)	0.72
Problems with pain after previous surgery	40 (1.8%)	6 (2.5%)	1.23	(0.77, 1.97)	0.40
Regular medications during pregnancy	1189 (55.4%)	136 (56.4%)	0.86	(0.61, 1.22)	0.40
Prolonged pain after previous birth	90 (4.1%)	16 (6.6%)	1.42	(1.04, 1.94)	0.025
Age	30 [14 to 50]	30 [16 to 46]	0.99	(0.96, 1.02)	0.54
BMI	28.3 [11.9 to 71.3]	27.9 [20.4 to 52.5]	0.99	(0.97, 1.02)	0.53
Somatization	28 [12 to 49]	27 [11 to 45]	0.97	(0.95, 1.00)	0.034
Gestational age at delivery	39 [24 to 47]	39 [25 to 42]	0.97	(0.91, 1.04)	0.38
Brussels (vs W-S)	462 (90.6%)	48 (9.4%)	0.70	(0.44, 1.13)	
New York (vs W-S)	305 (87.1%)	45 (12.9%)	1.29	(0.80, 2.06)	
Geneva (vs W-S)	638 (91.4%)	60 (8.6%)	0.87	(0.54, 1.39)	
Winston-Salem	785 (89.6%)	91 (10.4%)	Reference	--	0.17
Prior history of headache [‡]	39 (2.3%)	12 (6.1%)	--	--	0.001

[‡] Estimated on the N = 1924 valid measurements from the New York, Geneva, and Winston-Salem sites, 51 of whom reported a prior history of headache[‡] Due to missing data, model estimated on N = 1823 (74.6% of available participants)

Table 4

Predictors of headache within 72 hours after delivery

	No Headache After Delivery (n = 2343)	Headache After Delivery (n = 91)	Adjusted Hazard Ratio	95% Confidence Interval	P value
Headache during pregnancy	9.3% (217/2343)	29.7% (27/91)	3.83	(2.37, 6.18)	<0.0001
Epidural/Spinal/CSE Needle used	3.0% (68/2297)	9.0% (8/89)	2.19	(1.07, 4.50)	0.032
Epidural Morphine	2.7% (62/2297)	2.3% (2/89)	0.72	(0.34, 1.50)	0.369
Systemic Opioid PCA (Patient-Controlled Analgesia)	15.4% (353/2297)	11.2% (10/89)	0.76	(0.48, 1.20)	0.237
Oral Opioid	30.2% (693/2297)	31.5% (28/89)	1.03	(0.77, 1.38)	0.853
NSAIDs	89.5% (2055/2297)	91.0% (81/89)	1.07	(0.71, 1.59)	0.756
Acetaminophen	52.7% (1210/2297)	68.5% (61/89)	1.71	(1.32, 2.22)	<0.0001
Prior history of headache [†]	48 (2.6%)	3 (3.9%)	--	--	0.49

[†] Estimated on the N = 1924 valid measurements from the New York, Geneva, and Winston-Salem sites, 51 of whom reported a prior history of headache.