JOURNAL OF WOMEN'S HEALTH
Volume 23, Number 12, 2014

DOI: 10.1089/jwh.2013.4560

Risk Factors for Maternal Injuries in a Population-Based Sample of Pregnant Women

Karisa K. Harland, PhD,[1,2] Audrey F. Saftlas, PhD,[3] Jerome Yankowitz, MD,[4] and Corinne Peek-Asa, PhD[1]

Abstract

Background: The prevalence of injuries during pregnancy is largely underestimated, as previous research has focused on more severe injuries resulting in emergency department visits and hospitalizations. The objective of our study was to estimate the frequency, risk factors, and causes of injuries in a population-based sample of pregnant women.

Methods: This article is an analysis of postpartum interviews among the control series from a case-control study ($n = 1{,}488$). Maternal, pregnancy, and environmental characteristics associated with injury during pregnancy in control subjects were examined to identify population-based risk factors for injury. We collected data on self-reported injury during pregnancy, including the month of pregnancy, whether medical attention was sought, the mechanism of injury, and the number and location of bodily injuries. Logistic regression was used to calculate unadjusted and adjusted odds ratios (aORs) of injury.

Results: Over 5% of women reported an injury during pregnancy, with falls being the most common mechanism of injury. Women at highest adjusted risk for injury had unintended pregnancies (aOR: 2.28 [1.40–3.70]) and no partner during pregnancy (aOR: 2.45 [1.16–5.17]) relative to women without injuries.

Conclusions: Pregnant women with risk factors for many pregnancy-related complications are also at increased risk of injury during pregnancy. Further studies of pregnancy-related injuries are needed to consider environmental and maternal characteristics on risk of injury.

Introduction

Traumatic injuries during pregnancy are the leading nonobstetric cause of maternal death.[1,2] Between 5% and 7% of all pregnancies are complicated by injuries, and trauma in pregnancy remains a common cause of fetal death.[2–4] In a retrospective review of US fetal-death certificates, Weiss et al.[4] estimated that 5.4 per 1,000 fetal deaths were owing to maternal injury.

The scope of nonfatal maternal injury during pregnancy is difficult to estimate because less severe injuries may not require medical care and therefore go unreported. In the only population-based study to date of both unintentional and intentional injuries in pregnancy, 7.4% of women reported an injury during pregnancy.[3] In 2002, there were almost 17,000 injury-related hospitalizations in pregnant women, with over one-third of these resulting in a delivery at the time of injury.[5] Maternal traumatic injury can result in a myriad of pregnancy-related complications even if the mother is considered non-injured after examination.[6,7] Injury during pregnancy has been associated with a twofold increased risk of preterm labor and at least a 50% increased risk of placental abruption, which leads to increased risks of fetal distress and fetal death.[6–8]

The leading mechanisms of unintentional injury during pregnancy are motor vehicle crashes (MVC) and falls.[3–5,9,10] To date, the one population-based study of falls during pregnancy reported that 30% of women fell during pregnancy and that 10% experienced more than one fall during pregnancy.[10] Risk factors for falls during pregnancy include maneuvering stairs, slippery floors, hurrying, or carrying an object or a child.[10]

We conducted our analysis to assess the characteristics of women who reported any type of injury during pregnancy among only control women who delivered term and normally grown infants and participated in a previous population-based case-control study of preterm delivery and small-for-gestational-age infants. In addition, we examined the occurrence, mechanisms, timing, frequency, and location of unintentional

[1]Injury Prevention Research Center, University of Iowa, Iowa City, Iowa.
[2]Department of Emergency Medicine, University of Iowa Hospitals and Clinics, Iowa City, Iowa.
[3]Department of Epidemiology, University of Iowa, Iowa City, Iowa.
[4]Department of Obstetrics and Gynecology, University of South Florida, Tampa, Florida.

injuries sustained during pregnancy. We hypothesized that women at high risk (e.g., those who smoke, have an unintended pregnancy) for poor pregnancy outcomes (e.g., preterm delivery)[11,12] will also be at increased risk of injury during pregnancy.

Materials and Methods

Antenatal injuries were examined within the Iowa Health in Pregnancy Study (IHIPS), a population-based case-control study designed to determine the influence of intimate partner violence and maternal stress on the risk of preterm and small-for-gestational-age outcomes among live births to residents of four Iowa counties over the period May 2002 through June 2005. Control subjects were randomly selected from the population of women who delivered at term (37 or more weeks) over the study period. A subject's case-control status for analysis was verified by medical-chart review of gestational age at delivery and infant birth weight. Not all women selected as a control from the birth certificate were categorized as a control for analysis.[13] The subjects included in this analysis were control women verified by medical-chart review.[13] We examined risk factors for injury in controls only ($n = 1{,}488$) to ensure that the risks were associated with injury and not a poor pregnancy outcome (i.e., preterm delivery or small for gestational age). Subjects were ineligible if they were under 18 years of age at delivery ($n = 1$) or were excluded if they were non-English speaking ($n = 264$). A more detailed description of IHIPS has been published elsewhere.[13] All protocols and informed-consent procedures were approved by the University of Iowa Institutional Review Board.

Eligible women who provided verbal consent were asked to respond to a 45-minute telephone interview and provide signed consent for review of hospital records related to the delivery. The interviews were completed, on average, 43 weeks after delivery (range = 9–139 weeks, interquartile range = 20.9–68.9). The response rate among control subjects was 47.4%, and the participation rate was 55.5%.[14] Based upon women selected as controls from the birth certificate ($n = 1{,}923$), 7.6% ($n = 146$) were ineligible or excluded, and 47.4% ($n = 912$) completed the postpartum interview. Control subjects who participated in the study were more likely to be white (91% versus 87.9%), have higher education (18.4% versus 13.3% college graduate), and be less likely to smoke (7.8% versus 12.3%) than those who did not participate.

Interviewers asked women to report any injuries that occurred during the prenatal period, the mechanism and timing of the injury, as well as part(s) of the body injured. Each subject was asked ''Did you have any serious accidents or injuries during your pregnancy?'' Each subject was allowed to define ''serious''; no definition was provided by the interviewer. For any reported injury, information was collected on the month of occurrence, the mechanism of injury, and the part(s) of the body injured. In addition, women were asked whether they thought that the injury had affected the baby's health and whether medical care was sought. We classified the mechanism of injury using external causation codes (E-codes) from the International Classification of Diseases, ninth version, Clinical Modification.

Covariates

Pertinent maternal demographic and lifestyle characteristics and pregnancy histories were examined as potential risk factors for injury reported during pregnancy. The categorization of maternal age (18–19, 20–24, 25–29, 30–34, 35 +) was based on *a priori* knowledge. Other variables were maternal race (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific Islander, and other), education (less than or equal to high school, some college, college graduate [bachelor's], master's, or professional degree), prepregnancy body mass index (BMI) (< 24.9, 25–29.9, 30 +), gravidity, and parity. Pregnancy intention following conception was measured using questions from the Pregnancy Risk Assessment Monitoring System 2000–2003 Core Questionnaire (http://www.cdc.gov/prams/Questionnaire.htm). For multivariable logistic regression analysis, pregnancy intention was coded as intentional (wanted to be pregnant) or unintentional (wanted to be pregnant later, did not want to be pregnant at any time, or didn't care about the timing). Household and subject incomes were categorized into quartiles. We calculated poverty level based on guidelines determined by the Agency for Healthcare Research and Quality to account for the ratio of family income to the 2004 federal income thresholds while controlling for family size, with poor or near poor (< 125% of the federal poverty level), low income (125%–199% of poverty level), middle income (200%–399% of the poverty level), and high income (≥ 400% of the poverty level). Continuous variables, such as time spent heavy lifting at home, caring for children younger than 5 years old in the home, and leisure-time physical activity were categorized by quartile.

Analysis

To identify risk factors for injury during pregnancy, characteristics of control subjects were compared by injury status, using chi-square tests for categorical variables and the Student's *t*-test for continuous variables. Unadjusted and adjusted odds ratios were calculated to estimate the association of maternal characteristics with risk of injury when cell sizes were ≥ 5 using logistic regression. Pregnancy intention was considered a key predictor of injury risk because its relationship to injury has largely been unexplored; it is a risk factor for other pregnancy-related behaviors (e.g., continued smoking and alcohol use during pregnancy)[11] and poor pregnancy outcomes[12] and may help us to identify high-risk women. Finally, preconception pregnancy intention may be modifiable through education and provision of birth control, potentially resulting in increased intended or planned pregnancies and may result in a reduced injury incidence. Covariates were considered for inclusion in an adjusted model if the point estimates were altered by at least 10% *a priori*.

To describe the types of injuries sustained during pregnancy, we summarized data on the mechanism, timing during pregnancy, and body location of injuries. Data analysis was conducted using SAS® software, Version 9.2 of the SAS System for Microsoft (SAS Institute Inc., Cary, NC).

Results

Women in this analysis were, on average, 28.1 years of age; most were white, had at least some college education, worked during pregnancy, or were married. One in five women (21.2%) smoked during pregnancy, and 36.7% drank alcohol at some time during their pregnancy.

Over 5% (80 of 1,488) of women reported a ''serious'' injury during pregnancy; the prevalence varied substantially

Table 1. Maternal and Pregnancy Characteristics of Control Subjects by Any Reported Injury During Pregnancy, Iowa Health in Pregnancy Study, 2002–2005 (N=1,488)

Maternal/pregnancy characteristics	*Injured at any time during pregnancy: Yes (n=80)* n *(column %)*	*Injured at any time during pregnancy: No (n=1,408)* n *(column %)*	p-*value*[a]
Maternal age			
18–19	4 (5.0)	74 (5.3)	0.0014
20–24	30 (37.5)	270 (19.2)	
25–29	21 (26.3)	508 (36.1)	
30–34	14 (17.5)	388 (27.6)	
35+	11 (13.8)	168 (11.9)	
Maternal race			
White	63 (78.8)	1,201 (85.3)	0.1111
Nonwhite	17 (21.3)	207 (14.7)	
Maternal education			
≤High school	25 (31.3)	255 (18.1)	0.0144
Some college	26 (32.5)	459 (32.6)	
College graduate	17 (21.3)	476 (33.8)	
Master or professional	12 (15.0)	218 (15.5)	
Marital status			
Married	50 (65.8)	1,113 (81.4)	0.0002
Not married, in a relationship	14 (18.4)	181 (13.2)	
No partner	12 (15.8)	73 (5.3)	
Prepregnancy body mass index			
<18.5	3 (3.8)	92 (6.5)	0.7476
18.5–24.9	43 (53.8)	770 (54.7)	
25.0–29.9	19 (23.8)	312 (22.2)	
30+	15 (18.8)	234 (16.6)	
Smoked at any time during pregnancy			
Yes	27 (33.8)	289 (20.5)	0.0049
No	53 (66.3)	1,119 (79.5)	
Drank alcohol at any time during pregnancy			
Yes	30 (37.5)	516 (36.7)	0.8889
No	50 (62.5)	889 (63.3)	
Parity			
Primipara (0)	39 (48.8)	654 (46.5)	0.0578
1	17 (21.3)	454 (32.3)	
2+	24 (30.0)	298 (21.2)	
Pregnancy intention			
Wanted to be pregnant	31 (38.8)	861 (61.2)	0.0005
Wanted later	34 (42.5)	339 (24.1)	
Did not want	7 (8.8)	106 (7.5)	
Didn't care	8 (10.0)	100 (7.1)	
Pregnancy excitement following conception			
Excited	52 (65.8)	1,110 (78.9)	0.0216
Okay	16 (20.3)	186 (13.2)	
Not sure/ didn't want	11 (13.9)	111 (7.9)	
Household income ($)			
0–31,000	31 (41.9)	325 (24.5)	0.0102
31,001–56,000	14 (18.9)	343 (25.8)	
56,001–80,000	15 (20.3)	336 (25.3)	
80,001+	14 (18.9)	325 (24.5)	
Subject income ($)			
0–5,000	27 (34.2)	346 (25.2)	0.2529
5,001–19,000	21 (26.6)	347 (25.2)	
19,001–33,000	16 (20.3)	349 (25.4)	
33,001+	15 (19.0)	334 (24.3)	
Poverty threshold			
Poor/near poor	19 (25.7)	194 (14.6)	0.0262
Low income	12 (16.2)	180 (13.5)	
Medium income	25 (33.8)	460 (34.6)	
High income	18 (24.3)	495 (37.3)	
Worked during pregnancy			
Yes	58 (74.4)	1,100 (79.2)	0.3082
No	20 (25.6)	289 (20.8)	

[a]Column percent totals may be greater than 100% due to rounding.

by several maternal and pregnancy characteristics (Table 1). Injured women were significantly more likely than non-injured women to be 20–24 years old (37.5% versus 19.2%, p=0.0014), nonwhite (21.3% versus 14.7%, p=0.1111), or have no more than a high school degree (31.3% versus 18.1%, p=0.0144). Also at significantly increased risk were women who smoked during pregnancy (33.8% versus 20.5%, p=0.0049), those with unintended pregnancies (61.2% versus 38.8%, p=0.0005), and unmarried women (34.2% versus 18.6%, p=0.0002). Household income was inversely associated with risk of injury (p=0.0102).

Mechanisms, timing, and the type of injury are described in Table 2. The leading mechanism of injury was falling (n=35, 45.5%): 20 (26.0%) injured women reported falling on level ground, and an additional 15 (19.5%) reported falling from a height. MVCs were the cause of 29.9% of reported injuries. Fewer women were injured in the first trimester (16.5%) as compared to the second (41.8%) and third (41.8%) trimesters. Although most injured women reported an injury to one body part (67.5%), 17 women (21.3%) reported injury to two or more body parts. Nearly 85% (67/80) women sought medical care following the injury, with 68.7% (46/67) of those going to an emergency room. Almost 25% (19/80) of injuries were to the abdomen.

Several maternal and pregnancy characteristics were significant risk factors for an injury during pregnancy (Table 3). In unadjusted analyses, a high school education or less, not having a partner during pregnancy, smoking at any time during pregnancy, having an unintended pregnancy, being just ''okay'' about the pregnancy**,** and living at or below poverty level were associated with increased risk of injury. After controlling for maternal age at delivery, several maternal characteristics were associated with a twofold increased risk of injury: no more than a high school education (aOR=2.30 [1.15–4.61]), no partner during pregnancy (aOR=3.28 [1.59–6.77]), unintended pregnancy (aOR=2.28 [1.40–3.70]), and living near poor/poor poverty level (aOR=2.26 [1.08–4.74]). After adjustment for maternal age and

Table 2. Injury Mechanisms, Timing During Pregnancy, and Medical Care Sought, Iowa Health in Pregnancy Study, 2002–2005 ($N=80$)

Injury characteristic	*Injured subjects (n = 80) (n column%)*
Month of pregnancy injured	
Months 1–3	13 (16.5)
Months 4–6	33 (41.8)
Months 7–9	33 (41.8)
Seen by doctor for injury	
Yes	67 (84.8)
No	12 (15.2)
Went to hospital or ER for injury	
Yes	46 (58.2)
No	33 (41.8)
Mechanism of Injury	
Falls	35 (45.5)
Fall from height	15 (19.5)
Fall same level	20 (26.0)
Transportation related	23 (29.9)
Other	19 (24.7)
Number of body parts injured	
None	9 (11.3)
1	54 (67.5)
2+	17 (21.3)
Injury location	
Abdomen alone	11 (14.1)
Abdomen and other location(s)	8 (10.3)
Nonabdominal injury	59 (75.6)

ER, emergency room.

pregnancy intention, low education attainment and living near poor/poor poverty level were no longer significantly associated with risk of injury, but absence of a partner during pregnancy still presented a twofold (aOR = 2.45 [1.16–5.17]) increased risk of injury.

Discussion

Over 5% of women reported a serious injury during pregnancy. Consistent with previous literature, we found that in unadjusted analyses, women with less education, those who were younger, not married, or who smoked at any time during pregnancy were more likely to be injured during pregnancy.[3,10,15] After controlling for maternal age and unintended pregnancy, however, only lack of a partner during pregnancy remained a significant risk factor for injury.

We identified risk factors that were not consistent with those found in previous literature. Although the study by Tinker et al.[3] found no risk difference by pregnancy intention, we noted a twofold significantly increased risk of injury among women with unintended pregnancies. This difference may be owing to the populations sampled, the specific questions used to measure pregnancy intention, or the other study's ability to control for more covariates with a larger sample. In addition, including pregnancy intention in the multivariable model neutralized increasing age as a protective factor, and poverty has a risk factor for injury. We hypothesize that this may be owing to younger women being more likely to have unintended pregnancies.[16,17] Therefore, the two studies may be measuring a similar factor, although they were not strongly correlated ($r=0.30$, $p = <0.0001$). This same relationship may exist between living in or near poverty and unintended pregnancy ($r=0.34$, $p = <0.0001$), potentially reducing the effect of poverty.

Previous research into prenatal injury has focused on maternal exposures and characteristics, whereas little attention has been paid to the environment in which these individuals live. Our analysis is the first to report that living in poor or near-poor circumstances is associated with increased risk of injury during pregnancy. Poverty threshold is the ratio of income to the number of individuals in the home, standardized to federal poverty guidelines, a potentially better indicator of living conditions, crowding, and socioeconomic status than income alone. Of note, Tinker et al.[3] examined household income and family size as separate covariates in their adjusted model and found that these factors were not associated with an increased risk for injury. Taken together with our results, this finding suggests that income and family size alone may not be of importance until standardized to the federal poverty guidelines as a comparison to the general population.

As previously reported, the leading mechanisms of injury were falls and transportation-related.[3,6,8,15,18] For this reason, prenatal-care providers should discuss risks of falling during pregnancy to increase awareness that as pregnancy progresses, women will experience a shift in the center of gravidity as the abdomen extends beyond the pelvis, accompanied by a decrease in postural stability.[19,20] In addition, increased counseling in proper safety restraint use during pregnancy may not decrease a woman's risk of being involved in an MVC but could reduce the severity of injury to her and her unborn child should a crash occur.

Over 5% of women reported an injury during pregnancy; this prevalence is similar to several diseases of pregnancy (e.g., preeclampsia, gestational diabetes). We also found that many of the risk factors for injury are also risk factors for other pregnancy complications. Targeting all women, particularly those with an unintended pregnancy, for injury-prevention education during pregnancy may reduce the occurrence of these injuries.

Limitations to this study include recall bias, participation bias, the inability to classify the severity of injuries, and the potential for residual confounding owing to our small sample size. Subjects were asked to recall ''serious'' injuries, which may be more likely to result in seeing a doctor or going to a hospital, although over 15% of women reporting such an injury did not see a doctor for the injury. In addition, as the interviews were completed, on average, 9 months postpartum, women may have forgotten injuries, resulting in a reduced prevalence estimate. As women were asked to recall ''serious'' injuries, their interpretations of what is a serious injury may have varied, leading to inconsistent reporting of injuries during pregnancy. Participants were slightly more likely than nonparticipants to be white, have more education, and less likely to smoke, which may have some effect on generalizability. Therefore, the results reported here may not be generalizable to all pregnant women but only women similar to the participants. Even in the more socially advantaged group studied here, the risk of injury in pregnancy was still most prevalent among women who were younger, had less education, and had lower household incomes. Thus, the risk of injury among those who did not participate may be even higher, which would lead to an underestimation of

Table 3. Unadjusted, Age, and Pregnancy-Intention Adjusted Odds of Injury, Control Subjects, Iowa Health in Pregnancy Study, 2002–2005 (N = 1,488)

	Injured at any time during pregnancy		
Maternal/pregnancy characteristics	*OR [95% CI]*	*Age-adjusted OR [95% CI]*	*Age and pregnancy intention adjusted OR [95% CI]*
Maternal age			
Continuous	0.94 [0.91,0.99]	0.94 [0.91,0.99]	0.97 [0.93,1.02]
18–19	2.57 [1.32–4.99]		
20–24	2.24 [1.15,4.33]		
25–29	1.0 [Reference]		
30–34	0.87 [0.44,1.74]		
35+	1.58 [0.75,3.35]		
Maternal race/ethnicity			
White	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
Nonwhite	1.57 [0.90,2.73]	1.44 [0.82,2.53]	1.35 [0.77,2.37]
Maternal education			
≤High school	2.75 [1.46,5.18]	2.30 [1.15,4.61]	1.93 [0.95,3.92]
Some college	1.59 [0.85,2.96]	1.46 [0.77,2.76]	1.29 [0.67,2.46]
College graduate	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
Master or professional	1.54 [0.72,3.28]	1.64 [0.77,3.50]	1.73 [0.80,3.73]
Marital status			
Married	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
Not married but in a relationship	1.72 [0.93,3.18]	1.55 [0.79,3.02]	1.18 [0.59,2.35]
No partner	3.66 [1.86,7.17]	3.28 [1.59,6.77]	2.45 [1.16,5.17]
Smoked at any time during pregnancy			
Yes	1.97 [1.22,3.19]	1.72 [1.03,2.86]	1.50 [0.90,2.51]
No	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
Pregnancy intended			
Yes	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
No	2.49 [1.56,3.95]	2.28 [1.40,3.70]	2.28 [1.40,3.70]
Pregnancy excitement			
Excited	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
Okay	2.12 [1.07,4.17]	1.68 [0.93,3.03]	1.14 [0.60,2.19]
Not sure/didn't want	1.56 [0.75,3.24]	1.92 [0.96,3.83]	1.24 [0.58,2.62]
Household income ($)			
0–31,000	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]
31,001–56,000	0.43 [0.22,0.82]	0.47 [0.24,0.91]	0.52 [0.27,1.03]
56,001–80,000	0.47 [0.25,0.88]	0.54 [0.27,1.07]	0.65 [0.33,1.32]
80,001+	0.45 [0.24,0.87]	0.97 [0.92,1.03]	0.70 [0.32,1.52]
Poverty threshold			
Poor/near poor	2.69 [1.38,5.24]	2.26 [1.08,4.74]	1.74 [0.82,3.72]
Low income	1.83 [0.87,3.88]	1.63 [0.74,3.56]	1.30 [0.59,2.90]
Medium income	1.50 [0.81,2.78]	1.41 [0.76,2.65]	1.24 [0.66,2.35]
High income	1.0 [Reference]	1.0 [Reference]	1.0 [Reference]

CI, confidence interval; OR, odds ratio.

injury prevalence during pregnancy in our study. On the other hand, our sample population may be more likely to take risks during pregnancy, as the prevalence of smoking (20% versus 12.2%–13.1%)[21] and alcohol use (37% versus 12.2%)[22] in our sample of births is higher than that estimated nationally; therefore, our estimate may be inflated compared to the general pregnancy population. Finally, our sample is limited to women who have term and normally grown infants. Given that previous research suggests that injuries are associated with poor pregnancy outcomes, we may be underestimating the prevalence of injuries among all pregnant women.

Strengths of the research presented here include the study of a nonhospital or clinic-based population who provided information on injuries during pregnancy, mechanism of injury, body parts injured, trimester of injury, and numerous maternal and reproductive health characteristics. Previous studies on injuries during pregnancy have focused on how injuries affect pregnancy outcome, whereas our study identifies risk factors associated with an increased risk of injuries during pregnancy. Because injuries have been shown to impact pregnancy outcome, we must understand how to prevent injuries and the resulting negative outcomes. Through this analysis, we may have identified modifiable risk factors for injuries and high-risk pregnancy populations for targeted interventions. We were able to identify women at high risk based upon their individual characteristics and the environment in

which they live. In addition, pregnancy intention was identified as a risk factor for injury during pregnancy and may be used by clinicians to inform injury-prevention anticipatory guidance among women at greater risk for injury.

In conclusion, pregnant women are at high risk of injury. The occurrence of injuries is similar to that observed for other pregnancy-related complications. To date, very few population-based studies have been conducted to identify high-risk subgroups to target for education and prevention services. The current research suggests that women with unintended pregnancy, living in poverty, with less education, or without a partner during pregnancy are at increased risk and should be targeted. Further population-based research is needed to identify both environmental and individual risk factors associated with injury during pregnancy to guide evidence-based maternal education and effective preventive interventions.

Acknowledgments

This study was supported by grant RO1-HD39753 from the National Institute of Child Health and Human Development.

Karisa Harland was funded in part by the University of Iowa Injury Prevention Research Center supported by the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention (grant no. R49 CD001167).

Author Disclosure Statement

No competing financial interests exist.

References

1. Petrone P, Talving P, Browder T, et al. Abdominal injuries in pregnancy: A 155-month study at two level 1 trauma centers. Injury 2011;42:47–49.
2. Aufforth R, Edhayan E, Dempah D. Should pregnancy be a sole criterion for trauma code activation: A review of the trauma registry. Am J Surg 2010 199;387–389; discussion 389–390.
3. Tinker SC, Reefhuis J, Dellinger AM, Jamieson DJ, National Birth Defects Prevention Study. Epidemiology of maternal injuries during pregnancy in a population-based study, 1997–2005. J Womens Health (Larchmt) 2010;19: 2211–2218.
4. Weiss HB, Songer TJ, Fabio A. Fetal deaths related to maternal injury. JAMA 2001;286:1863–1868.
5. Kuo C, Jamieson DJ, McPheeters ML, Meikle SF, Posner SF. Injury hospitalizations of pregnant women in the United States, 2002. Am J Obstet Gynecol 2007;196:161.e1–e6.
6. Sperry JL, Casey BM, McIntire DD, Minei JP, Gentilello LM, Shafi S. Long-term fetal outcomes in pregnant trauma patients. Am J Surg 2006;192:715–721.
7. El Kady D. Perinatal outcomes of traumatic injuries during pregnancy. Clin Obstet Gynecol 2007;50:582–591.
8. El-Kady D, Gilbert WM, Anderson J, Danielsen B, Towner D, Smith LH. Trauma during pregnancy: An analysis of maternal and fetal outcomes in a large population. Am J Obstet Gynecol 2004;190:1661–1668.
9. Brown HL. Trauma in pregnancy. Obstet Gynecol 2009;114: 147–160.
10. Dunning K, Lemasters G, Bhattacharya A. A major public health issue: The high incidence of falls during pregnancy. Matern Child Health J 2010;14:720–725.
11. Dott M, Rasmussen SA, Hogue CJ, Reefhuis J, National Birth Defects Prevention Study. Association between pregnancy intention and reproductive-health related behaviors before and after pregnancy recognition, National Birth Defects Prevention Study, 1997–2002. Matern Child Health J 2010;14:373–381.
12. Shah PS, Balkhair T, Ohlsson A, Beyene J, Scott F, Frick C. Intention to become pregnant and low birth weight and preterm birth: A systematic review. Matern Child Health J 2011;15:205–216.
13. Harland KK, Saftlas AF, Wallis AB, Yankowitz J, Triche EW, Zimmerman MB. Correction of systematic bias in ultrasound dating in studies of small-for-gestational-age birth: An example from the Iowa Health in Pregnancy Study. Am J Epidemiol 2012;176:443–455.
14. Slattery ML, Edwards SL, Caan BJ, Kerber RA, Potter JD. Response rates among control subjects in case-control studies. Ann Epidemiol 1995;5:245–249.
15. Weiss HB, Sauber-Schatz EK, Cook LJ. The epidemiology of pregnancy-associated emergency department injury visits and their impact on birth outcomes. Accid Anal Prev 2008;40:1088–1095.
16. Hoffman CS, Messer LC, Mendola P, Savitz DA, Herring AH, Hartmann KE. Comparison of gestational age at birth based on last menstrual period and ultrasound during the first trimester. Paediatr Perinat Epidemiol 2008;22:587–596.
17. Haglund B. Birthweight distributions by gestational age: Comparison of LMP-based and ultrasound-based estimates of gestational age using data from the Swedish Birth Registry. Paediatr Perinat Epidemiol 2007;21 Suppl 2:72–78.
18. Schiff MA, Holt VL, Daling JR. Maternal and infant outcomes after injury during pregnancy in Washington State from 1989 to 1997. J Trauma 2002;53:939–945.
19. McCrory JL, Chambers AJ, Daftary A, Redfern MS. Dynamic postural stability in pregnant fallers and non-fallers. BJOG 2010;117:954–962.
20. Butler EE, Colon I, Druzin ML, Rose J. Postural equilibrium during pregnancy: Decreased stability with an increased reliance on visual cues. Am J Obstet Gynecol 2006;195: 1104–1108.
21. Tong VT, Dietz PM, Morrow B, et al. Trends in smoking before, during, and after pregnancy—Pregnancy Risk Assessment Monitoring System, United States, 40 sites, 2000–2010. MMWR Surveill Summ 2013;62:1–19.
22. Centers for Disease Control and Prevention (CDC). Alcohol use among pregnant and nonpregnant women of childbearing age—United States, 1991–2005. MMWR Morb Mortal Wkly Rep 2009;58:529–532.

Address correspondence to:
Karisa K. Harland, MPH, PhD
University of Iowa
200 Hawkins Drive, RCP 1008
Iowa City, IA 52242

E-mail: kari-harland@uiowa.edu