Women at risk: Trauma in Pregnancy—A systematic Review

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Abstract

Background: Trauma during pregnancy presents a major public health concern. The most common causes of trauma in pregnancy include motor vehicle collisions (MVC), assaults and falls. Both major and minor injuries have been shown to result in worse outcomes for mother and child. Identifying mothers at risk for these specific mechanisms of injury would help improve injury prevention programs for pregnant women.

Methods: We searched MEDLINE and the Cochrane databases from January 1, 1980 to January 31, 2012. Included articles were U.S.-based cohort and case-control studies with at least 50 injured pregnant women limited to the English-language investigating associations of socio-demographic variables with injury during pregnancy. Investigators abstracted all selected studies into a standardized collection format and completed a quality assessment based on recommendations by the PRISMA and STROBE criteria.

Results: Two hundred and twenty-seven abstracts were initially screened with 35 articles undergoing full review. Articles were rejected if they did not meet patient sample size inclusion criteria or did not analyze socio-demographic variables and the relationship to pregnancy-associated injury. Twelve articles were included in this review. Articles were separated into subgroups based on maternal mechanisms of injury, which included: all injuries, assaults, or homicides. The most frequently investigated socio-demographic variables included race, age, and insurance status. Studies were limited by differences in comparator groups, regional differences in demographics, and the observational design by the identified studies.

Conclusion: The evidence to identify high risk women for the common injury patterns during pregnancy is insufficient. This is especially true for MVC and falls. There is
Moderate evidence to support the risk for pregnancy-associated injury is influenced by young age, minority ethnicity and eligibility for government-assisted health care.

Identifying high risk pregnant populations for specific mechanisms of injury has the potential to target populations and improve patient counseling during pre-natal visits.
Introduction

Violence and injury in pregnancy is a major public health concern. Seven percent of all U.S. pregnancies are complicated by trauma.\textsuperscript{1,2} Trauma in pregnancy contributes higher morbidity and mortality for both fetus and mother.\textsuperscript{3-9} Significant injury invariably leads to poor maternal and fetal outcomes, but even minor injury can have detrimental consequences in neonatal outcomes.\textsuperscript{10,11} Minor injury during pregnancy has been correlated with low birth weight, premature births and congenital defects.\textsuperscript{3,6,7,11} Low educational level, young age, and low income have been implicated as risk factors for injury during pregnancy.\textsuperscript{7}

The three most common causes of trauma in pregnancy include motor vehicle collisions (MVC), falls, and assault.\textsuperscript{1} Blunt injury, including MVC, are by far the most common injury in pregnancy and is the leading cause of non-obstetrical maternal deaths.\textsuperscript{12} MVC is the most frequent cause of non-obstetrical hospital admission.\textsuperscript{13,14} Falls are another important cause of injury in pregnant patients, and account for 5-39\% of trauma-related injuries resulting in emergency department evaluations and admissions.\textsuperscript{15,16} Assaults are the second most common cause of non-obstetrical death in pregnant women, and are responsible for more deaths than any one medical condition during pregnancy.\textsuperscript{10} Intimate partner violence (IPV) during pregnancy is often difficult for health providers to recognize, but it remains a serious cause of pregnancy-associated injury.\textsuperscript{7,17} Domestic violence without severe trauma contributes to poor neonatal outcomes including premature birth and low birth weight.\textsuperscript{18,19} The aim of this review is to identify pregnant women at risk for emergency room evaluation or admission after trauma. We hypothesize that socio-demographic characteristics will aid in the identification of high-risk pregnant women. We also
hypothesize that socio-demographic variables will differ among pregnant women in respect to mechanism of injury. In order to identify the population of pregnant women at risk for severe injury we conducted a systematic review to answer the following questions: within observational case-control and cohort studies 1) Can we identify women that will require hospital evaluation and/or admission during pregnancy, and 2) Can demographic characteristics identify women at risk for specific injury patterns particularly injuries related to MVC, falls and assaults?

**Methods**

**Data Sources and Study Selection**

This systematic review includes published observational case-control and cohort studies that evaluate and identify risk factors for injury in the pregnant trauma population. We included studies from January 1, 1980 to the January 31, 2012. We chose from 1980 onward to coincide with expansion of state and regional trauma registries. In 1982, the American College of Surgeons Committee on Trauma (ASCOT) initiated the Major Trauma Outcome Study (MTOS) which became the reference database for seriously injured patients. By the mid-1980s, many states and regions established trauma registries, and by 1997 The National Trauma Data Bank (NTDB) started to combine data from various trauma registries. The NTDB currently collects data from over 900 registered U.S. trauma centers. Presently, there are 37 state trauma registries in the United States.

Cohort or case-control studies that included at the minimum of 50 pregnant subjects and investigated the of socio-demographic characteristics of pregnant women evaluated or
admitted to the hospital secondary to MVC, fall or assault were included in this review. Comparators involved non-injured pregnant patients or injured non-pregnant female patients (Table 1). Articles on maternal homicide or suicide were included if they studied associations of maternal characteristics with the risk death. Studies that collected demographic variables from the evaluated pregnant population were considered qualified for initial review. Studies of trauma in pregnancy were excluded if they reported data only on emotional abuse, self-reported injuries or injuries that were not evaluated by a physician. Articles that only reported on mechanism of injury and maternal or neonatal outcomes were not included. Published abstracts were not included. All material used has been peer-reviewed to be eligible for review. This review is restricted to U.S.-based populations. Maternal or neonatal outcomes were not necessary to be eligible for review.

Data Searches

Data collection process
We abstracted selected articles with the guidance of data collection instruments that assessed observational studies based on study design, population size, sources of bias, primary and secondary outcomes and statistical analyses. The quality checklist was created using elements of STROBE criteria.24 The checklist includes population size, distinguishes
between case-control and cohort study designs, includes a minimum of patient
demographic data and specific outcome measures. Demographic data consists of age, race,
insurance status among others. Specific outcome measures comprise hospital evaluation,
hospital admission or death from pregnancy-associated injuries.

Articles were initially evaluated by title and abstracts. The authors assessed the references
chosen for further review. The reviewers were not blinded to authors or institutions.

**Methodology for assessing risk of bias**

Selection, measurement, and confounder bias was assessed. Articles were classified as:
inadequate information for determination, low bias, moderate bias, or high bias. External
validity and the generalizability of outcomes to a larger population were graded as poor,
average or excellent. Disagreements between authors were resolved by the review of a
third assessor. Articles were excluded if were deemed high risk of bias in two or more
categories.

**Data synthesis**

For analysis, we divided studies into groups by comparator (injured non-pregnant women
versus uninjured pregnant women with a live birth) and mechanisms of injury (assault) or
injury-related deaths (homicides). The sub-groups were then assessed by quality and the
degree of bias. The PRISMA checklist was consulted at all stages during the development of
this review.

**Results**

Study Selection
Two hundred and twenty-seven abstracts were screened with 35 undergoing full review. Abstracts rejected lacked adequate subject sample size or did not include demographic data. Studies were removed during the full review if no analysis was performed to evaluate the relationship of socio-demographic variables and injury or specific injury mechanisms (i.e. MVC, assault, falls) during pregnancy. Twelve studies were included in this review (Table 2). Studies that met the inclusion criteria included articles that investigated injuries, assaults, or homicides during pregnancy (Table 3). We then stratified the articles based on their comparator groups or specific injury mechanisms (Table 4). All studies compared injured pregnant women (or injury-related pregnancy-associated death) to a control group. Control groups included either pregnant women with live births who did not sustain an injury during the pregnancy period or injured age-matched women who were not pregnant during the study period.

Patient populations included subjects identified from injury reporting databases or data-linked hospital discharge databases. Studies investigating pregnancy-associated assaults or homicides included women up to 1-year post-partum. Pregnancy-associated homicides were included in this review, as we believe this is an extension of pregnancy-associated assault. Overall, relatively few articles aimed to stratify the association of socio-demographic variables among pregnant women who sustain specific injury patterns especially injuries related to MVC or falls. However, most of the articles included in the category of “any injury” observed that MVC is the most likely form of injury during pregnancy. There were some studies on falls, but these relied on self-reported data, which did not meet our inclusion criteria. One study did report the relationship of falls on maternal and fetal outcomes, and reported demographic characteristics between
pregnant women with and without a hospitalization related to a fall, but differences were not analyzed between groups.\textsuperscript{27}

**Injured pregnant women versus uninjured pregnant women**

Three retrospective cohort studies describe socio-demographic differences between injured pregnant women and uninjured pregnant women, and assess the relationship of these variables with the risk of pregnancy-associated injury (PAI) (Table 5). El-Kady and colleagues addressed patient characteristics between women whose injury resulted in a delivery versus women who sustained a prenatal injury and delivered at a later time point.\textsuperscript{10} Nannini and colleagues studied the pregnancy-associated period, defined as pregnancy through the first year post-partum.\textsuperscript{15} Fischer and colleagues focused on the pregnancy period which did not include post-partum data.\textsuperscript{11}

El-Kady and Nannini found that injured pregnant women were more likely to be younger (<24 years), African American, have a high school degree or less, use public insurance, have high parity (3 or higher pregnancies), and receive no prenatal care or less prenatal care especially in the first trimester. On the contrary, Fischer and colleagues did not find an increase in injury among women with low education, nor did lack of prenatal care appear to be associated with an increase risk of injury in their study. Fischer and colleagues did not evaluate the role of insurance status or income on PAI. However, they did find tobacco use and the presence of medical problems were associated with an increase in injuries during pregnancy. El-Kady and colleagues found that women with an injury resulting in a delivery tended to be older (>26 years; \textit{p}<0.0001), and were more
educated (p<0.0007). They did not find an association between insurance status and PAI that resulted in a delivery.

In the study performed by Nannini and colleagues, one in seven pregnant women (13.7%) had at least one PAI. Both Nannini and Fischer found that unmarried status increased the risk for injury. Variables associated with the highest risk for PAI in the Nannini study included less than a high school degree (RR 2.48; 95%CI 2.39-2.58); being underinsured (RR:2.50; 95%CI 2.41-2.56), and being unmarried (RR: 2.58; 95%CI 2.50-2.66).

Quality of eligible studies

These three studies employ large state-representative databases from distinct regions of the United States. Taken together, this information may be generalizable to the national population. However, there are important limitations within each study. All studies identified women by a live birth or reported fetal death. This method would limit the capture of women with a non-viable delivery (i.e. <20 week gestational age). More than half of the women (55%) in the study by Nannini and colleagues sustained an injury within the first year post-partum, and thus it is difficult to accurately characterize pregnancy-related risk factors. Neither the Fischer nor Nannini study adjusted for the propensity of pregnant women to be hospitalized for less severe injuries when compared to non-pregnant women. Nannini and colleagues did note that the majority of visits (91%) captured in the data set occurred in the emergency department and did not result in an inpatient hospitalization. Since El-Kady and colleagues did not provide information on the severity of injury at the time of admission, it is difficult to determine if patient age and
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Educational status introduced bias in the decision-making of whether to proceed with an early delivery. All studies evaluate similar socio-demographic variables within geographically distinct regions. Nannini and colleagues study a Massachusetts-based patient population, El-Kady and colleagues: California, and Fischer and colleagues: Tennessee. Many patient characteristics are shared between studies such as young age, lower education, and inadequate prenatal care access.

Collectively, these studies suggest that young age, race and decreased access to health care increase the risk for PAI. By combining the data from these large studies from distinct regions, these risk associations are potentially nationally generalizable. Furthermore, these results imply that the rate and risk of PAI may be affected by ethnic disparities, state and regional educational differences, and access to health care.

**Injured pregnant women versus age-matched injured non-pregnant women**

Three retrospective cohort studies and one case control study compare injured pregnant women to age-matched non-pregnant women (Table 6). Both John et al (study pop.=218,157) and Ikossi et al (study pop. =77,321) utilized the NTDB.\(^{30,31}\) Weiss and Greenblatt et al evaluated single state-based non-governmental hospital discharge databases.\(^{32,33}\) The three cohort studies identified injured pregnant subjects by ICD-9 codes (Ikossi, Weiss, Greenblatt). John and colleagues identified pregnant women by the NTDB definition (urine human gonadotropin positive). All studies found that injured pregnant women were younger, more often a racial or ethnic minority (African American, Hispanic or Nonwhite) and more likely to use government-assisted health insurance than age-matched non-pregnant women. Ikossi and colleagues demonstrated that minorities were
twice as likely to be pregnant at the time of trauma than their white counterparts, and African American pregnant women experienced more intentional injury (suicide, homicide, assault) than non-African American pregnant women (19.5% versus 8.7%, p<0.0001). The studies that evaluated severity of injury in the pregnant population found that pregnant women had less severe injury (John: ISS<9; Ikossi: ISS<6) than non-pregnant women. Weiss adjusted for the propensity of pregnant women to be admitted for less severe injury, and reanalyzed patient characteristics of women admitted for >2 days. He found that young age and ethnic minorities continue to remain at higher risk for severe injuries during pregnancy. Ikossi and Weiss found that injuries occurring in pregnant women were less likely to be related to high risk behaviors such as drug intoxication or seatbelt disuse.

Quality of eligible studies

This collection of data consists of a combination of information from two state databases and two studies employing the national trauma registry. All studies have limitations based on their patient identification criteria. Studies that use ICD-9 codes to identify subjects may not capture women within the first trimester especially if no pregnancy tests were performed on admission. ICD-9 coding relies on the participation of medical coders and the accuracy and legibility of the medical chart, which would potentially miss subject identification. However, Weiss acknowledged the difficulty in identifying pregnant women in the early trimesters, and adjusted for this by including all women both pregnant and non-pregnant within the comparator group. John et al employ urine HCG as a method of PAI identification, but this is not a reliable method of pregnancy identification because it is less likely to be used in late-term pregnancy. No study assessed the relationship of
prenatal care access or education with the risk of PAI when compared to nonpregnant females.

These studies seek to identify characteristics that differ between pregnant women and the female trauma population as a whole. The strengths of these articles are bolstered by their large sample sizes and external validity. This aggregate of data indicates that young age, ethnic minority status and eligibility for government-assisted health care are associated with injury among pregnant women when compared to non-pregnant female trauma patients.

**Pregnancy-associated Homicides**

Three retrospective cohort studies address risk factors for homicide during pregnancy (Table 7). Pregnant homicide victims were compared to pregnant women with live births. Most studies include women post-partum up to one year. Palladino and colleagues conducted a multi-institutional study of pregnancy-associated violent deaths. Chang and colleagues utilized the Pregnancy Mortality Surveillance System at the Centers for Disease Control and Prevention. This national database collects information about all reported deaths in the U.S. that occur during pregnancy and 1 year postpartum. Dannenburg and colleagues evaluated pregnancy-associated homicides (PAH) within New York City. Postpartum women up to 6 months were included in their study.

All studies found that young age as defined as < 24 years or < 19 years was associated with an increased risk of homicides during pregnancy. However, Palladino and colleagues found that older women (>30 years; p<0.05) were also at higher risk for PAH than women ages 25-30. Being unmarried correlated with a higher risk of homicide in the
studies by Palladino and Chang. African American women appeared to have a higher burden of PAH. In the study by Palladino et al, African American women accounted for 44.6% of all PAH while contributing only 17.7% of live births (p<0.01). Chang and colleague reported that African American women had a PAH rate ratio approximately 7 times higher than white women, and Dannenburg and colleagues found the observed rate of homicides was significantly higher than the expected rate in pregnant African American women in New York City. Palladino and colleagues found that IPV preceded 45% of homicides, and the rate of PAH did not differ between States in the U.S.

After adjusting for age and minority status, Chang and colleagues observed that decreased level of education was associated with PAH. Less education (<12 years) was related to a significant increase in the homicide ratio (rate ratio: 2.5; 95% CI 2.5-2.6).

Dannenburg and colleagues demonstrated that drug or alcohol use was an important predictor of injury with around half of maternal-associated injury deaths (48%) having a positive toxicological finding at the time of autopsy. The authors also noted that the existing surveillance system had missed or did not identify the majority of pregnancy-associated injury-related deaths over the same study period.

Quality of eligible studies

This group of literature includes two nationally representative studies and one study limited to a large urban area. Sample sizes are substantial within the included articles. All studies relied on death reporting and the participation and accuracy of medical examiner evaluation and documentation. Pregnancy-associated violent deaths are most likely underreported, and most authors noted that pregnancy status is often undocumented on
death certificates. They also observed that autopsies did not frequently record the pregnancy status of homicide victims, and therefore it is possible that early trimester pregnancy or late post-partum would not be captured. The study by Dannenburg and colleagues showcases the inefficiency of data collection within reporting systems, and demonstrate that the concurrent reporting system did not identify up to 78% of injury-related pregnancy deaths. All studies examined age and race as risk factors for PAH, but other variables differed. No study evaluated the role of prenatal care access, income or insurance status with the risk of violent death.

Overall, limited information is available from the above studies to adequately characterize or identify women at risk for pregnant-associated homicides. Although these studies incorporated large sample sizes and two were nationally representative, we can only summarize that young age, black race and unmarried status may increase the risk for PAH. However, there is limited information from these studies to illustrate the role of education, income and access to care and their influence on the mitigation of PAH.

**Pregnancy-associated Assaults**

Two retrospective cohort studies assessed risk factors for assault during pregnancy (Table 7). Nannini and colleagues focused on the timing and rates of pregnancy-associated assaults in the state of Massachusetts. The authors analyzed the rate of maternal assault during all three trimesters and 12 months post-partum compared to women with live births. Weiss and colleagues utilized a multi-state discharge database.

Nannini and colleagues found that assault was highest in the first trimester (16.0 per 100,000) and lowest (5.8 per 100,000) during late pregnancy. The authors found a rise in
assault in the first year post-partum (post-partum 7-9 months: 10.5 per 100,000), but the rate of assault never surpassed the first two trimesters. The authors provided descriptive statistics which suggested that more Hispanic (25.2% versus 13.3%) and non-Hispanic black (23.0% versus 8.0%) pregnant women had assault-related hospital visits. Pregnant women with any assault visit were younger (<24 years; 63.1% versus 22.1%), had a high school degree or less (76.6% versus 36.1%), received government-assisted health insurance at delivery (86.7% versus 35.6%), and were more likely to be unmarried (83.4% versus 30.5%).

Weiss and colleagues found that pregnancy-associated assaults occurred at a higher rate in younger women, especially the 15-19 year age group (rate ratio 7.2; ISS adjusted rate ratio 2.49; 95%CI 1.31-3.63). The assault rate decreased for every subsequent age group. After analysis of pregnant women with ISS>4, race or ethnicity did not statistically influence the assault rate ratio. However, pregnant women with Medicaid did have an increase assault rate ratio after adjusting for injury severity (1.56, 95%CI 1.22-2.00).

Quality of Eligible Studies

These studies have very different descriptive aims and evaluate different sample populations. Based on our eligibility criteria, we could not synthesize a collective description of women at risk for pregnancy-associated assaults. Nannini et al suggest that the risk of injury is highest during the first and second trimester. These pregnancy periods have been difficult to capture within most studies. Weiss and colleagues use a large multi-state patient sample. By adjusting for injury severity, they address the bias that exists for admission of pregnant women regardless of injury severity. The authors demonstrate that
young age and race may influence whether pregnant women seek medical attention after an assault-related injury, but race alone is not a predictor of severe injury related to assault.

There is insufficient evidence from these two studies to extrapolate to the general population. However, both studies are consistent with previous work and suggest that assault occurs most often in the young and ethnic minorities. The Nannini study is the first study to suggest that the earlier trimesters may in fact have a higher risk of injury than late term pregnancy. These results underscore the importance of identifying early trimester pregnancies in future research and defining the role of early pregnancy on the burden of injury.

Discussion

There have been systematic reviews that focus on the significance of domestic violence, homicide and suicide during pregnancy.\textsuperscript{18,41} Although assault is an important cause of injury-related deaths during pregnancy, MVC and falls contribute to the majority of injuries sustained during the pregnancy period.\textsuperscript{10,11,35} Many of these reviews do not seek to identify women at risk for injury during pregnancy, which is necessary in the planning of effective injury prevention programs. We limited our search to the U.S. population to describe social and demographic risk factors that could aid in targeting antenatal women at highest risk for the most common injuries. We did not include international studies because differences in cultural practices and the availability of health services may not reflect the social dynamics within the U.S. population. There were a total of 50,955 cases of pregnancy-associated injuries, 9,961 pregnancy-associated assaults, and 871 pregnancy-
associated homicides represented in this systematic review (Table 8). The analytic methods differed substantially between studies. Analyses included odds ratios, relative risks, 95% confidence intervals and Student t-tests among others, and therefore a meta-analysis was not performed.

There were considerable differences among the studies in the variables examined. However, the influence of race, age, socioeconomics and education is noticeable. Young women and minorities (especially African American women) appeared particularly burdened with PAI and PAH. Regardless of race, women who used government-assisted health insurance were at higher risk for PAI. This suggests a major role for income and socioeconomic status as a predictor of injury (Table 8).

There are several confounders that may have affected patient demographics within studies. The increased likelihood of admission for pregnant women in comparison to non-pregnant women may have affected patient demographics. In addition, young age and low education may correspond to decreased health literacy, which would increase the inappropriate usage of emergency services. Finally, the use of government-assisted health insurance (i.e. Medicaid) may be over-represented in the pregnant population since pregnancy lowers the threshold for eligibility in government assistance programs such as the Supplemental Nutrition Program for Women, Infants and Children (WIC) and Medicaid.

Some additional risk factors for PAI and pregnancy-associated violent deaths remain unclear. There is conflicting evidence in regards to the relationship of high risk behaviors such as substance abuse and seat belt usage in pregnant women with the risk of injury. Ikossi et al and Weiss et al suggested that pregnant women were significantly less likely than their non-pregnant counterparts to engage in substance abuse or driving
without a restraint device. In contrast, Patteson and colleagues found that less than half (67/160) of pregnant women in motor vehicle collisions used a restraint device, and injured pregnant women were less likely to receive substance abuse testing (p<0.0002). Of the eighty-four pregnant women tested for intoxicants in their cohort, almost half of the women tested positive for drugs or alcohol.

We aimed to identify unique demographic risk factors related to MVC, falls, and assaults. However, many studies investigating pregnancy-associated vehicle collisions did not meet our inclusion criteria due to the lack of descriptive demographic data. Studies that did address fall risks either did not meet our inclusion criteria because they relied on self-reported injuries or did not provide analysis between demographics of pregnancy-associated falls and a comparator population.

Methods of identifying pregnant women amongst studies differed, and each method faced introduced selection bias in capturing injured pregnant subjects. Studies that relied on combined vital statistics and hospital discharge data were more likely to miss injuries associated with early-term pregnancy which did not result in a live fetus or a documented fetal death. The use of human gonadotropin levels to identify subjects with PAI in the NTDB may have had a tendency to capture women within the early trimesters, and we postulate that this method may have missed women in late pregnancy who do not typically receive the test on admission.

Screening for intimate partner violence during pregnancy has been recommended for over 25 years, and continues to be an important prevention strategy. Our review recognizes that assaults are major causes of injury in pregnant women. However, creating awareness among pregnant women of the significance of MVC and falls and their role in
poor maternal and fetal outcomes is imperative. Injuries especially motor vehicle collisions are the major contributor to maternal death. However, minor injuries also affect fetal outcomes which should further support the development of comprehensive prenatal injury prevention programs. Prevention strategies should at the minimum focus on young women and women meeting eligibility for public assistance for their prenatal healthcare.

**Conclusion**

In this review, we aimed to identify women at risk for the most frequent causes of injury during pregnancy. Our study selection focused on the pregnant population that surgeons and obstetricians are most likely to encounter in the emergency room or trauma bay. This systematic review was limited by the sheer lack of quality research dedicated to the identification of high risk pregnant women. However, the articles included in this review suggest that young age, low education and eligibility for government-assisted insurance (low income) are associated with PAI. There is insufficient evidence to stratify women at risk for certain injury patterns. Nevertheless, ethnic minorities especially African American women are over-represented among pregnancy-associated assaults and homicide. Although there is some evidence to support an association with race and pregnancy-associated assault or injury, we recognize that other factors such as community violence, housing conditions and substance abuse within the community likely play a role in the observed burden of injury among African American women and other ethnic minorities. Most studies poorly identified minorities within their study populations, and it is difficult to appreciate the burden of PAI in other racial and ethnic minorities such as Latinos and Native Americans. Future cohort studies should include large heterogeneous
populations including subjects from multiple states and regions that specifically examine maternal characteristics of pregnancy-associated MVCs and falls. As the fertility rates of minority women in the U.S. have surpassed those of Caucasian women, there needs be more emphasis in identifying and characterizing risk factors among minority women. Factors including education and health literacy, firearm or weapon access in the home, substance abuse by mother or partner, and housing conditions should be studied in relation to injury patterns. Additional studies should address the burden of high risk behaviors in the pregnant populations. Heath care providers should investigate the contribution of substance abuse among PAI just as they would for any trauma patient. We believe that identification of high risk pregnant women will result in efficacious prevention programs.

REFERENCES


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**Table 1. PICOTTS** (Patient population, Intervention, Comparison, Outcome, Type of question, and Type of Study)

**Table 2. Study Selection**

**Table 3. Study Characteristics of Articles included in the Systematic Review**

**Table 4. Subgroups of Pregnancy-associated Injuries**

**Table 5. Strength of evidence: Comparing risk factors of PAI with uninjured pregnant women**

**Table 6. Strength of evidence: Comparing risk factors of PAI with injured non-pregnant women**

**Table 7. Strength of evidence: Risk factors for PAH and pregnancy-associated assault**

**Table 8. Summary of Results**