PREVALENCE AND RISK OF HOSPITALIZED PREGNANT OCCUPANTS IN CAR CRASHES

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ABSTRACT

Hospitalized maternal injuries pose a serious threat to the fetus, therefore understanding their burden is important. In addition, this study examined whether the risk of serious injury from crashes changes during pregnancy. Using 1997 hospital discharge data from 19 states, injuries to younger women were classified as motor-vehicle related with and without pregnancy-associated diagnoses. The pregnancy screen identified 1,488 motor-vehicle occupant injury discharges (rate=129/100,000 person-years, rate-ratio=1.88, 95% CI=1.49, 1.98). Pregnancy-associated cases were younger, their median charge-per-visit and mean ISS were lower and their average length-of-stay was shorter. Once adjusted for severity, the age-specific rate-ratios were not significantly different than one.

The earliest accounts of trauma to pregnant women spoke of falls, "blows" and assaults as the leading mechanisms by which the mother and fetus fell victim (Brinton, 1884). By the mid-twentieth century, as Western society mechanized and motorized, automobiles rapidly rose to the fore. In the last couple of decades these trends have accelerated, with women, including women of reproductive age, taking to the road as never before. Concomitantly, many of the infectious scourges and complications of childbirth succumbed to the advances of modern health care and public health practice. The resulting changes in mortality patterns have led to the recognition that motor-vehicle related injuries are now the leading cause of death during pregnancy in many developed countries (Rochat, Koonin, Atrash, & Jewett, 1988; Weiss, 2001a), the leading cause of traumatic fetal injury mortality in the United States (Weiss, 2001b), and the leading cause of hospitalized trauma during pregnancy (Weiss, 1999a; Schiff, Holt, & Daling, 2001).

Maternal injury may put the fetus at great risk, yet since few state crash data systems include information regarding the pregnancy status of either drivers or passengers, little is known from population-based studies about the characteristics and risks of pregnant women involved in motor-vehicle crashes. Such information is necessary to understand the magnitude of maternal/fetal motor-vehicle trauma exposure, which women are at highest risk, and whether the risk increases or decreases in pregnancy or remains the same.

RESEARCH QUESTION/OBJECTIVE - This research sought to answer two primary questions:

1) What is the rate and burden of pregnancy-associated motor-vehicle (MV) hospitalizations in the U.S. for different age groups?

2) Is the risk of serious injury from MV crashes different for pregnant women compared to all women of the same age group?

METHODS

Hospital discharge data were solicited from states that mandated E-coding for 2 years or more or whose data showed an E-code completeness rate of 90% or better and at least 5 diagnosis fields to search for pregnancy-associated codes. Three states with large populations and fairly good completeness (>60%) but not mandated E-coding were also included.

States were contacted and arrangements made to receive non-confidential versions of statewide discharge data. Data were received from 19 states (AZ, CA, FL, ME, MD, MA, MI, NE, NH, NJ, NY, PA, RI, SC, UT, VT, VA, WA, and WI) whose population made up 51.9% of U.S. women ages 15-49. The 19 states represented the hospitalization experience of the 36 million women who were residents of those states and their 1.9 million live births (National Center for Health Statistics, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, 1999). The combined dataset covered complete counts from about 2,000 hospitals reporting 176,267 injury discharges to women ages 15-49.

DATABASE PREPARATION AND CASE SELECTION - The data underwent editing, filtering, grouping and development of derived variables to enhance compatibility, coding validity, and usability. Detailed algorithms were applied to identify injuries and to exclude cases of non-injury (e.g., surgical and medical care, place of injury codes, adverse drug effects and late effects).

Injury severity was calculated using ICDMAP-90 (Tri-Analytics Inc. Bel Air, MD); a computerized injury coder that assigns injury severity scores (ISS) based on ICD-9-CM injury diagnoses. ISS is a widely used severity score based on an anatomically based threat-to-life scale that ranges from 1 (minor) to 75 (unsurvivable) (MacKenzie, 1984). ICDMAP-90 does not take pregnancy conditions into account in its scoring.

Pregnancy association was defined by examining diagnosis fields for diagnostic codes including 630-669.9 (complications of pregnancy and childbirth), 760-779.9 (certain conditions originating in perinatal period) and "V" codes including V22 (normal pregnancy), V23 (supervision of high risk pregnancy), V24.0 (postpartum care immediately after delivery), V27 (outcome of delivery) and V28 (antenatal screening).

The above steps were applied to all age and gender injury discharges from the 19 states (n = 1,220,506) progressively limiting the data to females 15-49 years of age (n = 176,267), with acute care visits (n = 156,713), with valid injury E-code assignments (n = 144,260), who were residents of the state (n = 137,887), with an E-code for a motor-vehicle occupant-related injury (n = 24,675).

ANALYSES - Incidence rates were calculated per 100,000 person-years. For the pregnant population, denominators were derived from annual state-specific birth data and adjusted downward to account for the nine-month period of gestation and the assumption that the pregnancies would not be detectable in the hospital discharge data during the first two months of pregnancy. For example, if there were 1,000,000 live births in a population, it would be multiplied by 7/12 resulting in a denominator of 583,333 person-years for rate calculations. For all women, U.S. census data were used for the denominators.

Rate-ratios were constructed between pregnant and all women for different comparison groups. This comparison, rather than a pregnant versus "non-pregnant" group contrast, was done for several reasons. After subtracting pregnancy-associated cases, the referent group still contains some pregnant women in the first two months of their pregnancy and other pregnant women not detected by the diagnosis algorithm. Thus, it would be a misnomer to label it a "non-pregnant" group. Secondly, since the desire was to compare pregnant women to all women, the comparison takes into account the 5-month period of every pregnancy year in which pregnant women are not detectably pregnant, i.e., pregnant women contribute person-years to both groups since they are not pregnant over an entire year.

Rate-ratios were calculated by dividing the group-specific rate for pregnancy-associated injury discharges by the group-specific injury rate. Point and 95% confidence interval estimates of the rate-ratio were computed per standard methods (Rosner, 1994).

Motor-vehicle occupant related injuries to women of reproductive age were analyzed to present prevalence rates and rate-ratios for specific sub-groups. To adjust for the increased propensity of pregnant women to be hospitalized because they are pregnant, the data were re-analyzed including only cases with an injury severity score of four or greater.

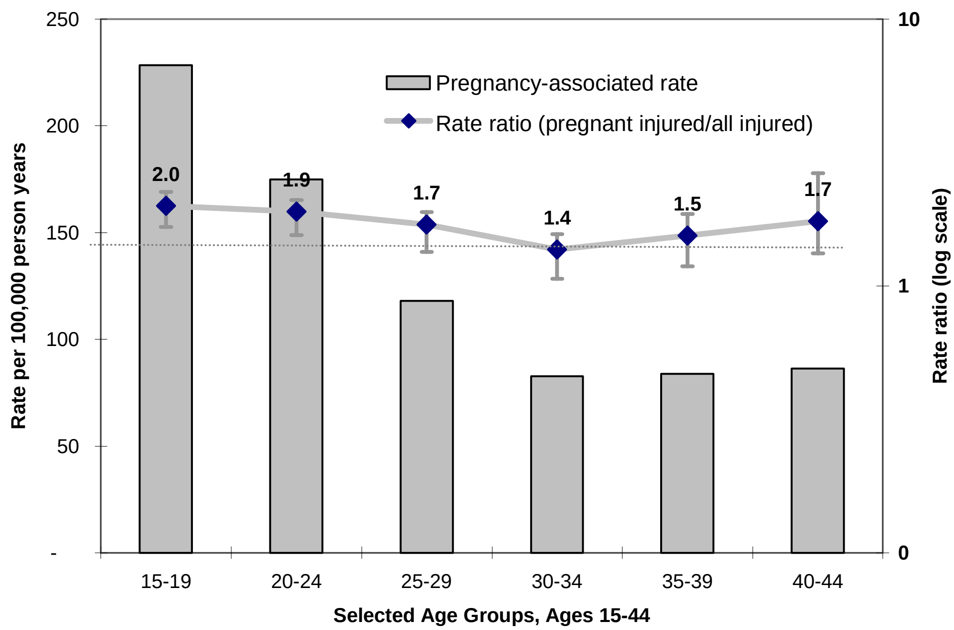
RESULTS

The E-coding was 92% complete among women 15-49 with one or more injury diagnoses. There were 137,887 women in this age range discharged from non-rehabilitation hospitals with an acute injury diagnosis and valid E-code, among which 5,498 (4.0%) were pregnancy associated. There were 24,675 (17.6%) motor-vehicle occupant (MVO) related injury discharges, among which the pregnancy screen identified 1,488 (6.0%) pregnancy-associated discharges.

Motor-vehicle occupant related injuries were the leading cause of hospital injury discharges among pregnancy-associated cases (27.1%), followed by falls (21.2%), poisonings (16.4%) and ‘struck by/against’ (8.2%). Pregnancy-associated injuries involving other motor-vehicle traffic related mechanisms included 108 pedestrians (2.0% of pregnancy-associated injuries) and 18 motorcyclists (0.3% of pregnancy-associated injuries).

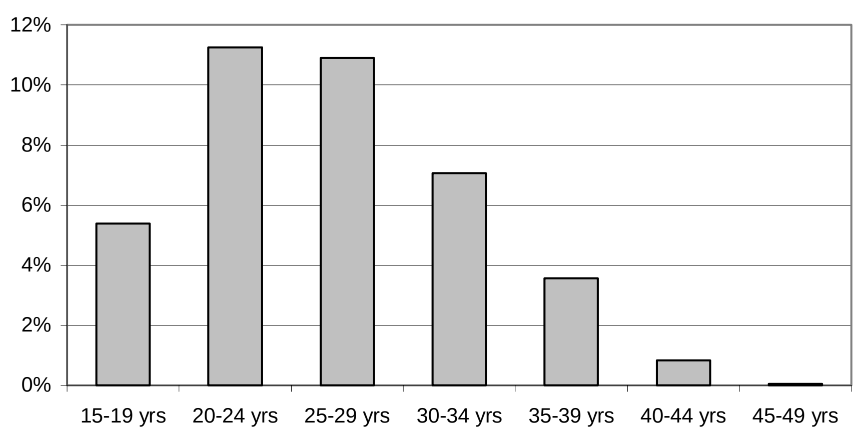
For MVO related injury discharges, the overall rate-ratio (pregnancy-associated divided by all cases of same age) was 1.88 (95% CI=1 .49, 1.98). This was derived by comparing the rate of 129 per 100,000 person years among pregnancy-associated cases versus 68 for all women 15-49. Age-specific rates for pregnancy-associated cases and rate-ratios (pregnant rate/all in group rate) are shown in Figure 1.

Figure 1. Pregnancy-associated rates and rate-ratios (with 95% confidence intervals) by age group, motor-vehicle occupant injuries, 19 state hospital discharge data, 1997.



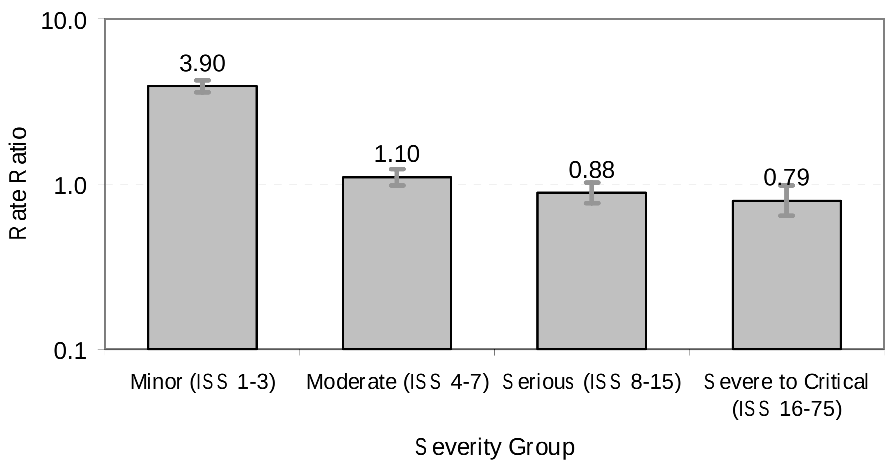
Pregnancy-associated women were younger (mean age = 25.4 versus 30.1 years) and minorities comprised a higher proportion of the pregnant group; 38.6% of pregnancy-associated discharges were non-white versus 26.9% for all women 15-49. The percentage in each age group that was pregnancy-associated is shown in Figure 2.

Figure 2. Proportion of pregnancy-associated motor-vehicle occupant injuries within each age group.



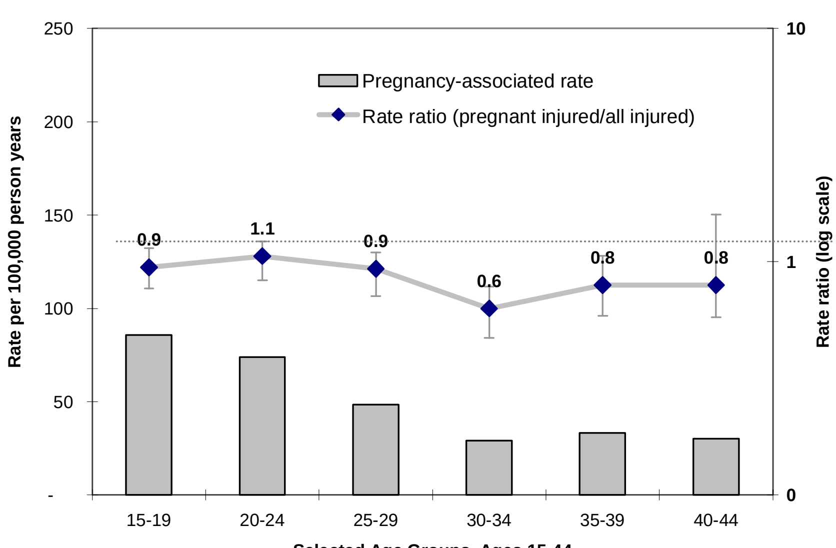
The average length of stay was shorter for pregnancy-associated injured women, 3.5 days versus 4.8. The mean ISS among the pregnancy-associated injured women was 4.9, while the mean ISS among all women 15-49 was 8.3 (see Figure 3 for the rate-ratio by ISS group). The median charge per visit was also less among the pregnancy-associated injured women ($5,096 versus $9,184)

Figure 3. Pregnancy-associated rate-ratios (with 95% confidence intervals) by injury severity score group, motor-vehicle occupant injuries, 19 state hospital discharge data, 1997.



Once adjusted for severity by dropping cases with an ISS < 4, most age-specific rate-ratios (shown in Figure 4) for MVO related injuries were not significantly different than 1 (overall rate-ratio = 0.97, 95% CI=0.74, 1.05).

Figure 4. Pregnancy-associated rates and rate-ratios (with 95% confidence intervals) after severity adjustment (ISS ≥ 4), motor-vehicle occupant injuries, 19 state hospital discharge data, 1997.



A summary of severity adjusted frequencies, rates and rate-ratios for selected traffic-related injuries is shown in table 1 below.

Table 1 - Frequencies, rates (in person years) and rate-ratios for selected traffic-related injuries after severity adjustment (ISS $\geq$ 4), 19 states, 1997

Mechanism	# Pregnant	Rate/ 100,000	# All Women 15-49	Rate/ 100,000	Rate-ratio	95% Confidence Interval
MVT Occupant	589	51	18,978	53	0.97	(0.89, 1.05)
MVT Motorcyclist	8	1	840	2	0.30	(0.15, 0.59)
MVT Pedestrian	59	5	2,400	7	0.77	(0.59, 0.99)

DISCUSSION

Among all women of reproductive age hospitalized with a MVO injury, 6% were pregnant; peaking at 11% among 20-29 year old women. One of the reasons for this seemingly high proportion of pregnant women hospitalized after a crash is that pregnant women appear to be more likely to be admitted for short hospital stays and minor injuries. When minor injury cases are omitted, pregnancy associated cases do not appear to have either an increased or a decreased risk for serious motor-vehicle related injury. The risk for serious (ISS $\geq$ 4) crash-related injury to pregnant women (51 per 100,000 person years) is not significantly different from that of all women 15-49 (53 per 100,000 person years).

A recent analysis of police reported crashes from the National Automotive Sampling System Crashworthiness Data System (NASS/CDS) (Weiss HB, 2002) showed a crash risk for reported pregnant occupants that was about one-half that of women in the same age range. Assuming that police reported crash risk rate-ratios and severity adjusted hospitalization risk rate-ratios should be about the same, this difference needs to be explained. We believe this is probably due to under-reporting pregnancy-associated crashes in the NASS/CDS system. Since the NASS/CDS cases are people in crashes who are usually not hospitalized; there is less opportunity for medical documentation of the pregnancy compared to medical records from inpatient stays. Secondly, current NASS/CDS coding rules state that when pregnancy status is “unknown”, cases are to be assigned to the “Female not-reported pregnant” category (U.S. Department of Transportation, National Highway Traffic Safety Administration, 1997). This can result in substantially lower rate calculations if a large percentage of cases have pregnancy status undetermined.

NATIONAL ESTIMATES - Table 2, below, shows the results of extrapolating from the 19 states hospitalization data to the

U.S. as a whole for the purpose of estimating the national burden of hospitalized pregnancy-associated MVO.

Table 2 – Extrapolated National Frequency and Monetary Impact of Hospitalized Motor-vehicle Occupant Injuries to Females of Reproductive Age, 1997.

Impact	Pregnancy-Associated	All Women (Ages 15-49)
Extrapolated Frequency	3,411	56,569
95% CI of Frequency Estimate	3,297-3,525	56,103-57,035
Total Hospital Charges	$44,307,900	$1,003,760,000

This extrapolation assumes there is a correlation between the rate of the age and gender specific motor-vehicle occupant fatality rate (obtained from national death data) and the hospitalized motor-vehicle injury rate and adjusts the estimates accordingly.* The extrapolation to national estimates takes into account the proportion of the US female population age 15-49 in the sample (51.9%) and an upwards adjustment for the observed lower female motor-vehicle occupant fatality rate among the 19 states (6.1 per 100,000) compared to the US rate (7.4 per 100,000). The extrapolation does not adjust for the partial lack of E-codes in the original data so it probably is a conservative estimate of the national burden of hospitalized motor-vehicle injuries to pregnant women.

LIMITATIONS – Like other analyses of secondary hospital discharge data, there are issues regarding the quality and completeness of mechanism coding and concern over possible duplicate counts. The study did not follow or interview individual women, thus, it could not elucidate patterns of injury before or after pregnancy or measure any fetal outcomes. The rate-ratios only reflect overall relative injury risk; they may or may not be the result of differential balancing across groups of the many factors that make up crash injury risk such as miles driven, crash severity, vehicle size and quality, or road and environmental conditions.

This paper looked at a snapshot of pregnancy-associated injuries from a single year. It did not look at multi-year trends. There are considerations that suggest that a trend analysis would show that the problem of pregnancy-associated crashes has increased substantially over the last 2 decades. This is because several reports from different industrialized countries have shown that between 1975-1990, primarily because more women are driving and driving

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* The correlation was quantified in the 19 states where both morbidity and mortality data were available. The Pearson correlation coefficient between the state specific discharge and mortality data was 0.860 including all 19 states and 0.903 when the two non-mandated E-code states were excluded (both significant at the .01 level, two-tailed).

more miles, the number of fatal crashes involving female drivers has increased by as much as 62% (Haapaniemi, 1996). With corroborating evidence from national vital statistics data of similar increases in neonatal deaths due to maternal trauma during this time span (Weiss, 1999b), it is suggested that we may be in the midst of a poorly documented motor-vehicle trauma induced epidemic of fetal loss and injury. Further, through descriptive and biomechanical investigations, we are only just now beginning to understand the nature and potential for serious non-fatal reproductive and developmental outcomes in the offspring that in the past have been inadequately linked to the in utero trauma (Baethmann, Kahn, Lenard, & Voit, 1996; Klinich, Schneider, Moore, & Pearlman, 1998; Pearlman et al., 2000; Klinich, Schneider, Moore, & Pearlman, 2000).

Because the selected states were a large convenience sample and not a random sample among the 50 states (plus the District of Columbia), some selected demographic and health indicator comparisons need to be made to qualify how the selected states differed from the nation as a whole. Various comparisons, shown in Table 3, below, help point the direction and magnitude of demographic differences between the 19 states and the rest of the United States. For example, the 19 states had age/gender specific injury death rates and motor-vehicle occupant death rates that were lower than the US as a whole (taken into account in the extrapolations, above). Birth and poverty rates, on the other hand, varied little.

Table 3 - Selected comparisons between the 19 states from which hospital data was collected and the US.

Comparison	19 State Rate	US Rate
1997 all injury death rate, females 15-49, per 100,000	24.9	27.7
1997 MVO death rates, females 15-49, per 100,000	6.3	7.5
1997 birth rate (live births/age specific female population, per 1,000)	55.4	56.0
1997 birth rate for black women (live births/age specific female population, per 1,000)	60.9	62.2
1997 poverty rate (percent)	13.1	13.1

CONCLUSIONS

This is the first study to measure the prevalence and risk of age-specific hospitalized pregnancy-associated motor-vehicle injury in a large multi-state population with severity adjustments. It estimates that at least 3,400 pregnant women are hospitalized annually in the U.S. with a crash related injury. This means that annually about one of every one-thousand births is exposed to a crash serious enough to result in the mother's hospitalization. This study also showed that women who become pregnant do not appear to change their overall risk of serious MVO injury.

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