Pregnancy-Associated Injury Hospitalizations in Pennsylvania, 1995

Harold Burton Weiss, MPH, PhD

From the Department of Emergency Medicine, Center for Violence and Injury Control, Allegheny University of the Health Sciences, Pittsburgh, PA.

Received for publication March 4, 1999. Revision received July 12, 1999. Accepted for publication August 23, 1999.

Presented at the annual meeting of the American Public Health Association, Washington, DC, November 1998, and as a poster at the Centers for Disease Control and Prevention–sponsored MICHEP Workshop, Atlanta, GA, December 1998.

Supported in part by the Pennsylvania E-Code Training and Analysis Project from the Pennsylvania Department of Health, which in turn was funded by the Centers for Disease Control and Prevention Preventive Health and Health Services Block Grant. The hospitalization data were provided by the Pennsylvania Health Care Cost Containment Council. The Pennsylvania Health Care Cost Containment Council and the Pennsylvania Department of Health specifically disclaims responsibility for any interpretations or conclusions of this work. The contents of this paper are solely the responsibility of the author and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

Address for reprints: *H Weiss, MPH, PhD, Center for Injury Research and Control, Presbyterian University Hospital, Suite B-400, University of Pittsburgh, 200 Lothrop Street, Pittsburgh, PA 15213; 412-648-9290, fax 412-648-8924; E-mail hweiss@injurycontrol.com.*

0196-0644/99/$8.00 + 0
47/1/102395

Study objective: To estimate the frequency of pregnancy-associated injury hospitalization and compare rates between pregnant women and all women of reproductive age by age, race, injury mechanism, intent, and other variables.

Methods: Using *International Classification of Diseases, Ninth Revision—Clinical Modification (ICD-9-CM)* selection criteria applied to Pennsylvania's 1995 acute hospital discharge data, all resident women ages 15 to 44 with coexistent pregnancy and injury-related diagnoses were identified for descriptive and comparative rate calculations.

Results: Seven hundred sixty-one (4.6%) of the discharges to injured women of reproductive age were associated with pregnancy. The leading injury causes among pregnant women were transportation-related (234 [33.6%]), falls (192 [26.4%]), poisonings (116 [16.0%]), and "struck by" (83 [11.4%]). Among all women 15 to 44 years, poisoning was the leading cause (32.6%) of injury, followed by transportation-related injuries (25.7%). The hospitalized injury incidence was 868 per 100,000 person-years for pregnant women versus 641 for all women ages 15 to 44 (rate ratio 1.35, 95% confidence interval [CI] 1.25 to 1.45). Pregnant women were younger (median age 24.9 years versus 30.0 years), their mean length of stay was shorter (2.5 days versus 3.7 days), the mean injury severity score was less (3.2 versus 4.8), and the median charge per stay was lower ($4,164 versus $6,051). Rate ratios (pregnant versus all women in same age group) were significantly higher for younger women 15 to 19 years (rate ratio 2.69, 95% CI 2.49 to 3.14). Rate ratios were significantly higher for assaults (rate ratio 3.04, 95% CI 2.45 to 3.78), falls (rate ratio 2.33, 95% CI 2.01 to 2.70), motor vehicle occupant (rate ratio 2.0, 95% CI 1.73 to 2.31), and struck by (rate ratio 3.73, 95% CI 2.97 to 4.69). Rate ratios were lower for poisonings (rate ratio 0.71, 95% CI 0.59 to 0.86) and self-inflicted injuries (rate ratio 0.62, 95% CI 0.50 to 0.77).

Conclusion: Pregnant women were more likely than all women 15 to 44 years to be hospitalized for injury and more likely to be hospitalized for assaults, falls, transportation-related, and less severe injuries, but less likely for poisonings and self-inflicted injuries. Much of the increased risk appears to be concentrated in young women. Further work is needed to establish to what extent the observed increases are the result of increased injury rates or increased hospitalization rates.

[Weiss HB: Pregnancy-associated injury hospitalizations in Pennsylvania, 1995. *Ann Emerg Med* November 1999;34:626-636.]

INTRODUCTION

Injuries and violence to pregnant women are major public health concerns. Not only is the woman involved, but 2 lives, intimately connected, may be adversely affected. Over the past century, much has been done to diminish the adverse effects of medical conditions on maternal morbidity and mortality, and the medical and public health communities continue to place great emphasis on lowering maternal morbidity and mortality. But all too often, the important and proportionately increasing role of injuries and violence in maternal and fetal well-being have been excluded by definition.[1-3] When viewed from an inclusive vantage point—all deaths occurring during pregnancy—injuries become the leading cause of maternal death and an important source of maternal morbidity.[4]

With the ready availability of state and national mortality data, several maternal mortality studies have shown injuries as a major and leading cause of maternal mortality, with homicide and motor vehicle–related deaths among the chief causes.[1,2,4-6] Yet, the completeness of mortality data is in question. In New York City, for example, Dannenberg et al[1] found that only 35% of the death certificates had noted the pregnancy in a series of 115 maternal injury-related deaths.[1] Another problem with mortality data is that they examine only the tip of the iceberg. Different patterns and different possible interventions may well emerge from studying morbidity (nonfatal) patterns related to differences in case-specific mortality rates.[1] Finally, the much higher frequency of nonfatal maternal injuries may be as great as or even a greater source of adverse fetal outcomes than fetal loss caused by fatal maternal injuries.[7] Therefore, one must look to serious, but not necessarily fatal maternal events, to better understand the risks of injuries to pregnant women and the fetus.

The usefulness of most nonfatal maternal injury studies has also been of concern. Although many hospital-based case series exist,[8-15] few population-based studies of injuries among hospitalized pregnant women have been conducted. Most case series have followed small populations, drawn from unique (unrepresentative) clinical populations, lacked comparison groups, or focused on a few injury causes. The largest and most recent case series described 476 pregnant women seen at a tertiary care center and community hospital.[15] Motor vehicle–related injuries accounted for 55% of the cases and 22% were associated with falls. Intentional injuries comprised 22% of all cases. In a recent review of violence and pregnancy, among 13 articles covering the period 1965 through 1995, only one covered hospital inpatients[16] (5 hospitals were in this study sample) and only 2 studies were population-based. The latter 2 were based on surveys of the general population, but because of sample size limitations would not be expected to predict the magnitude of inpatient visits.[17,18]

Bennet et al[3] studied all pregnancy-associated hospitalizations in the United States using the 1991 and 1992 National Hospital Discharge Survey (NHDS). Injury diagnoses were detected, but the lack of E-coding (injury mechanisms) in the NHDS and the relatively small number of injuries in the overall sample limited its usefulness for understanding the role of injuries. The only other population-based study of hospitalized maternal injury was published by Greenblatt et al.[19] They studied Maryland hospital discharge data for the 12-year period 1979-1990. Among 80,311 injured women 15 to 44 years, 2,185 (2.7%) were pregnant. They reported that 34% of the injuries involving pregnant women were motor vehicle–related, 19% were related to falls, 20% were self-inflicted, and 10% were assault-related. They reported the rate ratio (comparing pregnant patients with all women 15 to 44 years) for assault-related hospitalization was 1.14 (not statistically significant). Although this latter study brought fresh understandings and creative methodologic approaches to the area of study, it contained several drawbacks:

- The E-coded data were only about 50% complete because E-codes had not been mandated in Maryland over most of the study period.
- The injury and pregnancy selection codes were not as refined or as expansive as they could have been.
- In 1992, after the Maryland study, accreditation mandates for emergency department domestic violence screening and hospital identification of victims of abuse should have improved the detection of assaults.

Recognizing many of these issues, the authors recommended their analyses of pregnancy-associated injury hospitalizations be repeated on a "population based hospital discharge dataset that is fully E-coded." This study, with some modifications, does that. Our aims were to refine and quantify estimates for the magnitude of pregnancy-associated injury hospitalizations and to describe differences in hospitalization rates between pregnant women and all women of reproductive age by age, race, injury mechanism, intent, and other variables.

MATERIALS AND METHODS

To extend the population-based approach of Greenblatt et al,[19] we reviewed Pennsylvania's statewide hospital discharge survey data for 1995, obtained from the Pennsylvania Health Care Cost Containment Council through the State Department of Health. Pennsylvania's population in 1995 was approximately 12 million persons, 2.65 million of whom were females between the ages of 15 and 44. The annual hospital discharge database contained records of about 2 million hospitalizations and accommodates 9 *International Classification of Diseases, Ninth Revision—Clinical Modification (ICD-9-CM)* coded diagnostic fields and 1 E-code field. Birth and population data used in rate calculations were obtained from the Pennsylvania Department of Health[20] and the US Census Bureau. Because no personal identifiers are in this database and no linkage or followup was performed, institutional review board approval was exempted.

Records were selected among resident females between the ages of 15 and 44 (inclusive) discharged from an acute care institution listing coexistent pregnancy and injury-related diagnoses. Pregnancies were identified by looking at diagnosis fields for *ICD-9-CM* diagnostic ranges including 630-669.9 (complications of pregnancy and childbirth), and 760-779.9 (certain conditions originating in perinatal period), and "V" codes ("Supplementary Classification of Factors Influencing Health Status and Contact with Health Services") V22 (normal pregnancy), V23 (supervision of high-risk pregnancy), V24.0 (postpartum care immediately after delivery), V27 (outcome of delivery), and V28 (antenatal screening). Injuries were identified by selecting cases with either an injury-related E-code (excluding adverse effects) or an *ICD-9-CM* diagnosis in the range 800-999.99 with specific exclusions (because some diagnoses in this range are not injuries or are not usually considered injuries). For example, excluded were complications of surgical and medical care (996-999.9 and E870-E879.9), injuries coded only with E849-E849.9 (place of injury), adverse effects of therapeutic drugs (E930-E949.9), and late effects of injury (905-909.9, E929-E929.9). Details regarding the specific case selection criteria are available from the author on request.

Injury severity was measured by the Injury Severity Score (ISS),[21] an anatomically based threat-to-life scale that ranges from 1 (minor) to 75 (unsurvivable). It was imputed by ICD-MAP (Tri-Analytics Inc, Bel Air, MS). ICD-MAP is a computerized injury coder that automatically assigns abbreviated injury scale (AIS) codes, Injury Severity Scores (ISS, mathematically computed from 1 or more AIS scores), among other variables. ICD-MAP works by analyzing each record's (patient's) diagnosis codes and performs AIS/ISS conversion for most, but not all *ICD-9-CM* codes between 800 and 959.9. Drug and alcohol involvement was determined by searching for coexisting drug- or alcohol-related *ICD-9-CM* diagnoses such as 291, 292, 303, 304-5, 571, 965, and 967-970 (precise search strategy available on request).

Following the methodology of Greenblatt et al,[19] incidence rates were calculated per 100,000 person years. For the pregnant population, denominators were derived from birth estimates obtained for the study year and adjusted downward to account for the 9-month period of gestation (not a full year of pregnancy) and the assumption that the pregnancies would not be known to the women or detectable in the hospital discharge data during the first 2 months of pregnancy. For example, if there were 100,000 live births over the year in the population being studied, multiplying 100,000 by 7/12 represents the actual person-years of exposure (ie, the person-years among which women could have had their pregnancies identified).

Comparisons (rate ratios) were constructed between pregnant injured women and all women 15 to 44 years. This comparison, rather than a pregnant versus "nonpregnant" group contrast, was done for several reasons. After subtracting known pregnant cases, the referent group still contains some pregnant women in the first 2 months of their pregnancy and other women not detected by the diagnosis algorithm. Thus, it would be a misnomer to label it a "nonpregnant" group. Second, the comparison group arguably should include in the person-year calculations of the denominator, the 5-month period of every pregnant year in which pregnant women are not detectably pregnant. It is noted that the issue of whether to compare the pregnancy-related injuries with the entire group or the entire group minus the person-years of the pregnancy-related injuries is somewhat academic as the

rates for all reproductive age women are similar to "nonpregnant" women of the same age, because more than 90% of women 15 to 44 years are not pregnant at any given point in time.[1]

Rate ratios were calculated by dividing the group-specific (*ICD* group, race, ethnicity, age, mechanism, intent, and so on) rate for pregnancy-associated injury hospitalizations by the group-specific injury rate for all women 15 to 44 years old. In accord with the methods of Greenblatt et al[19] and Dannenberg et al,[1] the consequences of multiple births and spontaneous and induced abortions in the person-year calculations were ignored because of their assumed small effect and the difficulty of obtaining accurate enumerations of these conditions in the study population. The point and 95% confidence interval (CI) estimates of the rate ratio, comparing the pregnant and all injured women 15 to 44 years old, were computed as per standard methods detailed by Rosner.[22]

Three subsets were created and analyzed. First, the issue of violence in pregnancy was of special interest; therefore, all assault-related injuries were analyzed separately so that rates of assaults could be computed for age- and race-specific subgroups. Second, cases with the *ICD-9-CM* code of 644 (early or threatened labor) were examined to begin to look at fetal risks. Third, to adjust for the increased propensity of pregnant women to be hospitalized because they are pregnant and not just because of the underlying injury, we reanalyzed the main results tables including only cases with a length of stay of 2 days or more. This led to exclusion of 385 (50.6%) of the pregnancy-related injuries and 6,369 (38%) of all injuries from the length of stay of 2 days or more adjusted analyses (Figure 1).

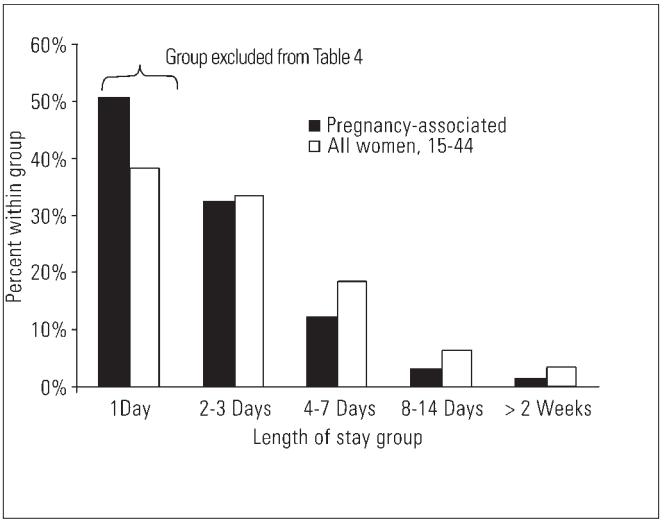
RESULTS

There were 16,722 women age 15 to 44 who were hospitalized with an injury diagnosis in Pennsylvania in 1995. Among these women, the screening identified 761 pregnancy-associated injury discharges (4.6% of all women age 15 to 44 hospitalized with an injury diagnosis). The leading causes of injury among pregnant women were transportation-related (33.6%; of these, more than 80% were motor vehicle occupant–related), falls (26.4%), poisonings (16.0%), and struck by or against (11.4%). Among all women age 15 to 44, poisoning was the leading cause (32.6%), followed by transportation-related injuries (25.7%; of these, 78% were motor vehicle occupant–related), falls (16.5%), and struck by or against (4.5%). Among nonwhite women 15 to 44 years old with both an injury and pregnancy-associated diagnosis, 19.6% (54/276) were assault-related, whereas for white women, it was 7.6% (32/419).

The pregnancy-associated injured women were younger compared with all women 15 to 44 (mean age 24.9 versus 30.0 years), and minorities comprised a higher proportion of the pregnant group; 39.1% of pregnancy-associated discharges were in nonwhite women versus 20.7% of all women age 15 to 44 (reflecting in part the higher birth rate in the nonwhite population). The median charge per visit was $4,164 for pregnant women and $6,051 for all women. The average length of stay was shorter for the pregnancy-associated injured women, 2.5 days versus 3.7 for all women age 15 to 44. The mean ISS among the 288 pregnancy-associated injured women who were assigned a score was 2.5, whereas the mean ISS among all women 15 to 44 who received a score (8,901) was 4.8. Drug or alcohol involvement was greater among all women 15 to 44 years than pregnant women (30.2% versus 12.2%).

The incidence of hospitalized injury per 100,000 person-years was 868 for pregnant women and 641 for all women ages 15 to 44 (rate ratio 1.35, 95% CI 1.25 to 1.45). Rate ratios (pregnant versus all women ages 15 to 44) were particularly and significantly higher for younger women ages 15 to 19 (rate ratio 2.69, 95% CI 2.49 to 3.14) and ages 20 to 24 (rate ratio 2.24, 95% CI 2.06 to 2.56), assaults (rate ratio 3.04, 95% CI 2.45 to 3.78), falls

Figure 1.
Length of stay groupings for injury-related hospital discharges for women age 15 to 44 for pregnancy-associated discharges and all discharges, Pennsylvania, 1995.



(rate ratio 2.33, 95% CI 2.01 to 2.70), motor vehicle occupant (rate ratio 2.0, 95% CI 1.73 to 2.31) and struck by (rate ratio 3.73, 95% CI 2.97 to 4.69). Rate ratios were significantly lower for poisonings (rate ratio 0.71, 95% CI 0.59 to 0.86) and self-inflicted injuries (rate ratio 0.62, 95% CI 0.5 to 0.77). Tables 1 through 3 detail the rates of pregnancy-associated hospitalized injury and rates for all women of reproductive age (15 to 44 years) for these and other selected characteristics.

Figure 2 compares the rate of hospitalized injury per 100,000 person-years, by 5-year age groups for pregnant injured women and all injured women age 15 to 44 by

Table 1.
Rates of pregnancy-related hospitalized injury and rates for all women of reproductive age (15 to 44 years) by selected characteristics, Pennsylvania, 1995.

		Pregnant Women		All Women			
Variable	**Value**	**No.**	**Rate***	**No.**	**Rate***	**Rate Ratio**	**95% CI**
Age (y)	15–19	170	1,834	2,791	682	2.69	2.49–3.14†
	20–24	242	1,287	2,342	574	2.24	2.06–2.56†
	25–29	158	627	2,486	614	1.02	0.94–1.20
	30–34	120	518	2,970	651	0.80	0.74–0.96†
	35–39	65	672	3,264	689	0.97	0.90–1.25
	40–44	6	378	2,869	630	0.60	0.56–1.34
	Total	761	868	16,722	641	1.35	1.25–1.45†
Race	White	444	605	12,310	530	1.14	1.05–1.26†
	Nonwhite	285	1,982	3,214	963	2.06	1.93–2.32†
Age/race: White	15–19	77	1,220	2,093	632	1.93	1.78–2.42†
	20–24	144	964	1,689	508	1.90	1.74–2.25†
	25–29	102	469	1,781	497	0.95	0.87–1.15
	30–34	73	356	2,142	525	0.68	0.62–0.86†
	35–39	44	519	2,427	543	0.96	0.88–1.29
	40–44	4	‡	2,178	517	‡	‡
Age/race: Nonwhite	15–19	83	2,808	451	863	3.26	3.04–4.11†
	20–24	86	2,224	509	967	2.30	2.16–2.89†
	25–29	51	1,465	545	1,006	1.46	1.37–1.94†
	30–34	43	1,618	622	1,101	1.47	1.38–2.00†
	35–39	20	1,663	602	1,033	1.61	1.51–2.51†
	40–44	2	‡	485	928	‡	‡
Hispanic	Yes	35	924	557	818	1.13	1.05–1.59†
	No	726	865	16,140	631	1.37	1.27–1.48†
Severity	Minor (ISS 1–3)	166	189	3,130	118	1.61	1.37–1.88†
	Moderate (ISS 4–7)	91	104	3,964	149	0.70	0.56–0.86†
	Serious (ISS 8–15)	29	33	1,419	53	0.62	0.43–0.89†
	Severe to critical (ISS 16–75)	2	‡	388	15	‡	‡
Length of stay	1 d	385	439	6,369	240	1.83	1.65–2.03†
	2–3 d	248	283	5,616	211	1.34	1.18–1.52†
	4–7 d	93	106	3,075	116	0.92	0.75–1.13
	8–14 d	25	29	1,078	41	0.70	0.47–1.04
	>2 wk	10	11	584	22	0.52	0.28–0.97†
Payer source	Patient direct bill	19	22	649	24	0.89	0.56–1.40
	Medicare	5	‡	576	22	‡	‡
	Medicaid	244	278	4,371	165	1.69	1.49–1.92†
	Blue Cross	87	99	2,841	107	0.93	0.75–1.15
	Commercial	282	321	5,983	225	1.43	1.27–1.61†
	Employer direct bill	4	‡	90	3	‡	‡
	Other government	3	‡	61	2	‡	‡
	Unknown/other	117	133	2,151	81	1.65	1.37–1.98†

Data modified from Pennsylvania Health Care Cost Containment Council, 1995.
*Rates are presented per 100,000 person-years.
†Statistically significant, $P<.05$.
‡Rates and ratios not computed for cells with 5 or less observations.

race. The rate of nonwhite injury-related discharges (both pregnant and all cases) was generally higher than that of whites, and the rate of pregnancy-associated injury discharges was much higher among younger nonwhite women.

Age-group specific rates with associated rate ratios and 95% CIs (pregnant injured women/all injured women) for assault-related cases are shown in Figure 3. The pregnancy-associated rates and rate ratios were all highest in the youngest age group, declining with age. The overall rate of pregnancy-associated assaults was 101 per 100,000 person-years, but it was almost 9 times higher (not shown) in nonwhite women than white women (376 versus 44). The rate ratio, however, was elevated similarly among both white women (3.11, 95% CI 1.85 to 4.48) and nonwhite women (2.29, 95% CI 1.97 to 3.03). Among white women and nonwhite women, about 10% of all assaults were accompanied by a pregnancy-related diagnosis. The highest rates were observed in the youngest age groups. For example, among nonwhite women 15 to 19 years, the rate of pregnancy-associated assaults per 100,000 years was 744 and the rate ratio was 5.26 (95% CI 4.46 to 8.46). Most of the pregnancy-associated assaults (70.0%, 62/89) reported the mechanism of injury as "struck by or against" with a rate ratio of 4.57 (95% CI 3.50 to 5.97). Pregnancy-associated assaults

Table 2.
Rates of pregnancy-related hospitalized injury and rates for all women of reproductive age (15 to 44 years) by mechanism and intent of injury, Pennsylvania, 1995.

	Pregnant Women		All Women			
Variable	**No.**	**Rate***	**No.**	**Rate***	**Rate Ratio**	**95% CI**
Mechanism						
MVT occupant	199	227	3,012	113	2.00	1.73–2.31†
Fall	192	219	2,493	94	2.33	2.01–2.70†
Poisoning	116	132	4,923	185	0.71	0.59–0.86†
Struck by, against	83	95	673	25	3.73	2.97–4.69†
MVT unspecified	23	26	132	5	5.28	3.39–8.22†
Other specified, NEC	18	21	345	13	1.58	0.98–2.54
Unspecified	16	18	527	20	0.92	0.56–1.51
Other specified and classifiable	15	17	496	19	0.92	0.55–1.53
Cut/pierce	13	15	605	23	0.65	0.38–1.13
Bites/stings	8	9	220	8	1.10	0.54–2.23
MVT pedestrian	8	9	245	9	0.99	0.49–2.00
Transport, other	8	9	233	9	1.04	0.51–2.10
Overexertion	7	8	416	16	0.51	0.24–1.08
Firearm	6	7	155	6	1.17	0.52–2.65
Hot object/substance	3	‡	108	4	‡	‡
MVT other	3	‡	44	2	‡	‡
Other natural/environmental	3	‡	65	2	‡	‡
Fire/flame	2	‡	104	4	‡	‡
Machinery	1	‡	36	1	‡	‡
MVT motorcyclist	1	‡	102	4	‡	‡
Pedal cyclist, other	1	‡	67	3	‡	‡
Pedestrian, other	1	‡	23	1	‡	‡
Drowning/submersion	—	—	9	<1	—	‡
MVT pedal cyclist	—	—	20	1	—	‡
Suffocation	—	—	30	1	—	‡
Intent						
Unintentional	536	611	9,746	367	1.67	1.53–1.82†
Self-inflicted	84	96	4,100	154	0.62	0.50–0.77†
Assault	89	101	886	33	3.04	2.45–3.78†
Other/unspecified	18	21	351	13	1.55	0.97–2.49

MVT, Motor vehicle traffic; **NEC**, not else classified or classifiable.
Data modified from Pennsylvania Health Care Cost Containment Council, 1995.
*Rates are presented per 100,000 person-years.
†Statistically significant, $P<.05$.
‡Rates and ratios not computed for cells with 5 or less observations. Cells with no observations indicated by dashes (—).

were more likely to be nonfatal (rate ratio 3.08, 95% CI 2.48 to 3.83) and of short length of stay (rate ratio for 1-day length of stay 4.95, 95% CI 3.69 to 6.64). The payer source for pregnancy-associated assault discharges was more likely to be listed as Medicaid (rate ratio 3.51, 95% CI 2.59 to 4.76).

Another group of particular interest because of its implication for fetal outcome were those cases with the *ICD-9-CM* code of 644, early or threatened labor. There were 102 such cases identified for a rate of 116 per 100,000 person-years. The rate was substantially higher in nonwhite women than white women (313 versus 70) and was also highest in the younger age groups. Most cases were coded as unintentional (80%). There were 18 assaults in this group (18%), mostly associated with the mechanism of "struck by" (13/18). Transportation-related causes dominated with 39% of the cases related to motor vehicle occupant injury, motor vehicle traffic unspecified, and other transport causes. Falls were the next highest mechanism category with 30%, followed by "struck by object" at 19%.

There were also 10 discharges containing the specific *ICD-9-CM* code of 634, spontaneous abortion/miscarriage. One half of these cases (5) were motor vehicle occupants.

Table 4 details the rates of pregnancy-associated hospitalized injuries and rates for all women of reproductive age for selected characteristics among women with a length of stay greater than or equal to 2 days. With this selection proportionately eliminating more pregnancy-associated cases, most rate ratios more than 1 were reduced. The overall rate ratio decreased to a nonsignificant 1.08 (95% CI 0.98 to 1.20). Rate ratios were still significantly elevated for subgroups including younger age groups in both white women and nonwhite women and for fall, motor vehicle traffic occupant, and struck-by mechanisms. The rate ratio for assaults decreased to 1.97 (95% CI 1.41 to 2.75) with the rate ratio among nonwhite women still significantly elevated at 1.61 (95% CI 1.33 to 2.44), especially among nonwhite women ages 15 to 19 (rate ratio 3.64, 95% CI 2.86 to 8.22), whereas a similar (1.72) but not statistically significant rate ratio was observed among white women (95% CI 0.88 to 3.15).

DISCUSSION

This study extends the understanding of the risk of hospital admission for serious injury in pregnant women. It is the first to describe the burden of pregnancy-associated hospitalized injury in a statewide pop-

Table 3.
Rates of pregnancy-related hospitalized injury and rates for all women of reproductive age (15 to 44 years) by nature of injury derived from the first listed injury diagnosis, Pennsylvania, 1995.

	Pregnant Women		All Women			
Nature of Injury (*ICD-9-CM* range)	**No.**	**Rate***	**No.**	**Rate***	**Rate Ratio**	**95% CI**
Fractures, dislocations, sprains, and strains (800–848)	119	136	5,008	189	0.72	0.60–0.86†
Intracranial injury (850–854)	38	43	1,310	49	0.88	0.64–1.21
Internal injury to chest, abdomen, and pelvis (860–869)	18	21	498	19	1.09	0.68–1.75
Open wound (870–897)	36	41	1,105	42	0.99	0.71–1.37
Injury to blood vessels (900–904)	—	—	43	2	—	‡
Late effects (905–909)	7	8	402	15	0.53	0.25–1.11
Superficial, contusion and crushing injury (910–929)	71	81	671	25	3.20	2.51–4.09†
Foreign bodies (930–939)	2	‡	74	3	‡	‡
Burns (940–949)	7	8	224	8	0.95	0.45–2.01
Injury to nerves and spinal cord (950–957)	3	‡	90	3	‡	‡
Traumatic complications (958–959)	130	148	326	12	12.07	9.85–14.80†
Poisonings (960–979)	106	121	4,686	176	0.68	0.56–0.83†
Toxic effects of nonmedicinals (980–989)	6	7	309	12	0.59	0.26–1.32
Other and unspecified effects (990–995)	7	8	77	3	2.75	1.27–5.97†
Injuries outside 800–995 and invalid	211	241	1,899	71	3.36	2.92–3.88†

Data modified from Pennsylvania Health Care Cost Containment Council, 1995.
*Rates are presented per 100,000 person-years.
†Statistically significant, $P<.05$.
‡Rates and ratios not computed for cells with 5 or less observations. Cells with no observations indicated by dashes (—).

ulation where the cause of injury coding (E-code) has been mandated and more than 90% complete for several years. It is the first to describe a statistically significant increase in the rate ratio for pregnancy-associated assaults in a population-based manner, even after adjusting for some degree of predisposition toward short-term hospitalization of pregnant women given similar types of injuries compared with their nonpregnant peers. It showed that most of the observed increases in assaults were focused among the youngest women, 15 to 24 years old. The study also shows that transportation-related injuries are the leading cause of hospitalized maternal injury and suggests they are also the leading cause of hospitalization for early or threatened labor because of injury.

Although the refined diagnosis code–based pregnancy screening technique appeared to have led to slightly improved detection of pregnancy-associated conditions compared with published methodology, the most important gains in sensitivity were probably the results of the increased number of searchable diagnostic fields (9 compared with 5) and the impact of improvements in overall E-coding and violence-related E-coding since the Maryland study was performed.[1] Until recently, the use of hospital records and *ICD* E-codes to identify hospitalized victims of violence and domestic violence greatly underestimated violence events. Intentional injuries were often classified as unintentional because of a lack of documentation of the intent of the injury in the medical record and biased coding conventions. However, these assumptions may no longer hold because of (1) the imposition in 1992 of national Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirements for emergency department screening of domestic violence, (2) the 1994 JCAHO requirement to establish criteria to identify victims of abuse throughout the hospital, and (3) medical recommendations for abuse screening during prenatal care released in 1995.[23] These changes may explain, in part, the greater risk of assaults in the pregnant-associated population in this study compared with the earlier Maryland study (97 versus 23/100,000 person-years). The difference may also be attributable in part to differing sociodemographic characteristics and observational time periods.

To put the assault-related findings into perspective, abuse during pregnancy occurs more often than many regularly screened pregnancy complications.[24] But whether pregnancy itself is related to an increase in assaults has not previously been established. In a recent *JAMA* review, Gazmararian et al[25] pointed out the limitations of existing studies in this area. They described the difficulty of drawing conclusions from previous studies about violence risk during pregnancy versus other times in a woman's life and from studies that have used different methods and measures of violence and unique populations. The current study addresses many of those issues and raises the important concern that among younger

Figure 2.
Rate of hospitalized pregnancy-associated injuries per 100,000 person-years, by age and race, Pennsylvania, 1995.

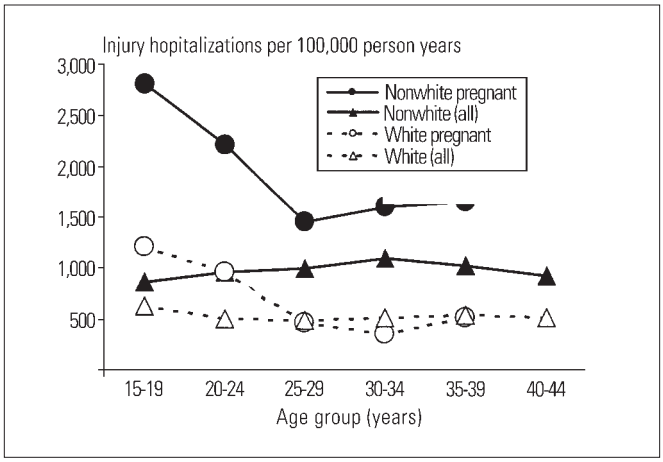
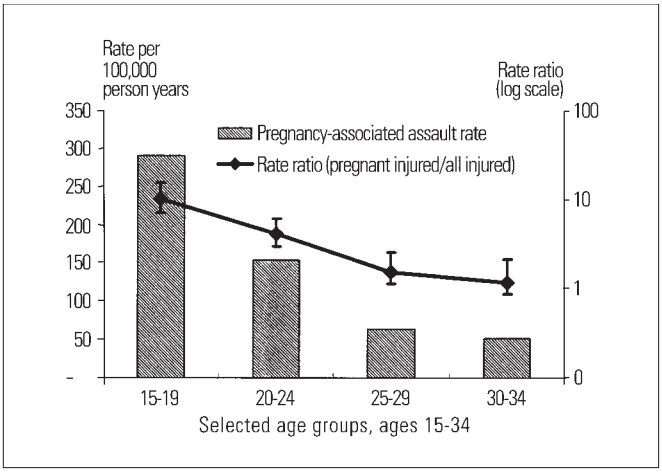


Figure 3.
Rate of assault-related hospitalized pregnancy-associated injuries per 100,000 person-years and rate ratio with 95% confidence interval (pregnant injured women/all injured women) for ages 15 to 34, Pennsylvania, 1995.



women, hospitalized assaults may be increased during the detectable period of pregnancy explored by this study.

Several limitations of this study should be noted. First, as pointed out by others, there is good evidence that pregnant women are more likely than nonpregnant women to be hospitalized for minor conditions because of appropriately cautious clinical judgment.[19,26] Pregnant women may have higher hospitalization rates for conditions where the actual rates of the event are much the same. This study partially controlled for this phenomenon by eliminating all pregnancy-associated cases with lengths of stay less than 2 days in a subanalysis. However, this type of stratification may not eliminate all concerns over this issue and more refined and stringent types of adjustment should be considered in future studies of this type.

Second, multiple hospitalizations in the same year by the same pregnant woman may result in some duplicate counts, and individuals with multiple visits may be classi-

Table 4.
Rates of pregnancy-associated hospitalized injury and rates for all women of reproductive age (15 to 44 years) with length of stay ≥2 days for selected characteristics, Pennsylvania, 1995.

		Pregnant Women		All Women			
Variable	**Value**	**No.**	**Rate***	**No.**	**Rate***	**Rate Ratio**	**95% CI**
Age (y)	15–19	70	755	1,548	379	2.00	1.80–2.54†
	20–24	109	580	1,357	333	1.74	1.56–2.12†
	25–29	87	345	1,487	367	0.94	0.85–1.17
	30–34	72	311	1,902	417	0.75	0.68–0.94†
	35–39	34	351	2,144	453	0.78	0.71–1.09
	40–44	4	‡	1,915	420	‡	‡
	Total	376	429	10,353	397	1.08	0.98–1.20
Race	White	240	327	7,652	330	0.99	0.89–1.13
	Nonwhite	118	821	1,976	592	1.39	1.28–1.67†
Hispanic	Yes	18	475	335	492	0.97	0.88–1.55
	No	358	427	10,001	391	1.09	0.99–1.21
Age/race: White	15–19	34	539	1,162	351	1.53	1.38–2.16†
	20–24	70	469	1,004	302	1.55	1.39–1.98†
	25–29	59	272	1,067	298	0.91	0.81–1.19
	30–34	47	229	1,370	336	0.68	0.61–0.91†
	35–39	27	319	1,586	355	0.90	0.81–1.31
	40–44	3	‡	1,463	347	‡	‡
Age/race: Nonwhite	15–19	29	981	229	438	2.24	2.04–3.30‡
	20–24	35	905	283	537	1.68	1.55–2.39‡
	25–29	23	661	325	600	1.10	1.02–1.68‡
	30–34	23	865	396	701	1.23	1.15–1.88‡
	35–39	7	582	407	699	0.83	0.77–1.76
	40–44	1	‡	336	643	‡	‡
Leading mechanisms	Fall	95	108	1,764	66	1.63	1.33–2.00†
	MVT occupant	85	97	1,918	72	1.34	1.08–1.67†
	Poisoning	75	86	2,434	92	0.93	0.74–1.17
	Struck by, against	32	36	418	16	2.32	1.62–3.32†
	MVT unspecified	11	13	88	3	3.78	2.02–7.08†
	Unspecified	11	13	335	13	0.99	0.55–1.81
	Other specified and classifiable	9	10	352	13	0.77	0.40–1.50
	Bites/stings	7	8	165	6	1.28	0.60–2.74
Intent	Unintentional	257	293	6,395	241	1.22	1.07–1.38†
	Self-inflicted	53	60	2,162	81	0.74	0.57–0.97†
	Assault	37	42	568	21	1.97	1.41–2.75†

MVT, Motor vehicle traffic.
Data modified from Pennsylvania Health Care Cost Containment Council, 1995.
*Rates are presented per 100,000 person-years.
†Statistically significant, $P<.05$.
‡Rates and ratios not computed for cells with 5 or less observations.

fied in more than one group if the coding or event was not consistent from one visit to the next. Most hospital discharge systems do not flag multiple visits; they are discharge-based, not person-based. Among enlisted servicewomen, Adams et al[27] determined that as many as one third of the women with an antenatal hospitalization were hospitalized more than once, but without linked records we were unable to account for multiple hospitalizations in our study. However, unlike the study by Adams et al, the population here is selected from the general population and would need multiple admissions with both a pregnancy and an injury code, rendering multiple admissions in our study population less likely.

Third, the assumption that population rates computed for all reproductive age women (used in the rate ratio calculations) are similar to nonpregnant women of the same age, slightly lowers the power to show differences in risk between the pregnant and nonpregnant groups and has a small potential for introducing bias by age, race, and other factors associated with the probability of being pregnant.

Fourth, hospital discharge data are affected by the quality and consistency of coding among the hospitals contributing to the system.[28-31] For intentional injuries, the precise methods for screening and documentation are not always specified and may vary from place to place. Perfectly accurate coding systems do not exist. As long as these vagaries are consistently applied within and among hospitals, consistent results may be obtained. Thus, the results seeking to contrast pregnant women may be valid from a comparative standpoint, but less so from a vantage seeking complete enumeration. Rare miscoding does occur, but it is difficult to conjecture how systematic inclusions of pregnancy-associated codes among nonpregnant women, the type of error that could most affect the results, would occur. However, it is acknowledged that interhospital coding differences combined with variation in hospital-specific incidence rates could lead to confounding and clustering effects.

Finally, women in early pregnancy are not likely, or at best, much less likely than women in later pregnancy, to have the pregnancy identified and coded during a hospital stay. These cases will be misclassified into the nonpregnant group. Therefore, an *ICD* (diagnosis)-based pregnancy definition, such as that used in the current study is biased toward detection of later-gestation pregnancies and does not adequately address risks in early pregnancy. Future studies in this area would greatly benefit from routine pregnancy screening among young female inpatients and documentation of the results in the summary discharge record and data systems.

For workers in health and human services and the justice system, this work is potentially very useful. It serves to make the public and professionals more aware of the variety and changes in injury risks to pregnant women, both intentional and unintentional. Applying these methods consistently on a national or state-by-state basis may be a useful tool for setting national and statewide Healthy People objectives. A larger sample will allow for confirmation of the findings and finer statistically significant disaggregation of different factors of interest and offers the ability to better stratify by injury severity measures while maintaining adequate sample sizes. Ultimately, these findings should be applied to better prioritize and target a diversity of effective injury prevention efforts aimed toward young women for the benefit of the mother and the fetus.

I thank Drs Andrew Dannenberg, Jeffrey Coben, and Sam Forjuoh for their thoughtful review and encouragement. The methodology in this study builds directly on that pioneered by Drs Greenblatt, Dannenberg, and Johnson.

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