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Pregnant driver-associated motor vehicle crashes in North Carolina, 2001–2008

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ABSTRACT

Background: Motor vehicle crashes are the leading cause of maternal injury-related mortality during pregnancy in the United States, yet pregnant women remain an understudied population in motor vehicle safety research.
Methods: We estimated the risk of being a pregnant driver in a crash among 878,546 pregnant women, 16–46 years, who reached the 20th week of pregnancy in North Carolina (NC) from 2001 to 2008. We also examined the circumstances surrounding the crash events. Pregnant drivers in crashes were identified by probabilistic linkage of live birth and fetal death records and state motor vehicle crash reports.
Results: During the 8-year study period, the estimated risk of being a driver in a crash was 12.6 per 1000 pregnant women. Pregnant women at highest risk of being drivers in serious crashes were 18–24 years old (4.5 per 1000; 95% confidence interval, CI,4.3, 4.7), non-Hispanic black (4.8 per 1000; 95% CI = 4.5, 5.1), had high school diplomas only (4.5 per 1000; 95% CI = 4.2, 4.7) or some college (4.1 per 1000; 95% CI = 3.9, 4.4), were unmarried (4.7 per 1000; 95% CI = 4.4, 4.9), or tobacco users (4.5 per 1000; 95% CI = 4.1, 5.0). A high proportion of crashes occurred between 20 and 27 weeks of pregnancy (45%) and a lower proportion of crashes involved unbelted pregnant drivers (1%) or airbag deployment (10%). Forty percent of crashes resulted in driver injuries.
Conclusions: NC has a relatively high pregnant driver crash risk among the four U.S. states that have linked vital records and crash reports to examine pregnancy-associated crashes. Crash risks were especially elevated among pregnant women who were young, non-Hispanic black, unmarried, or used tobacco. Additional research is needed to quantify pregnant women's driving frequency and patterns.

1. Introduction

In the United States, motor vehicle crashes are the leading cause of maternal injury-related death during pregnancy (Rochat et al., 1988). A pregnant occupant crash rate of 13 per 1000 person-years was estimated from a probability sample of pregnant occupant crashes in the U.S., while a rate of 26 per 1000 person-years was estimated for non-pregnant women during the same period (Weiss and Strotmeyer, 2002). However, the pregnant occupant crash rate is likely an underestimate due to difficulties in capturing cases. Statewide crash surveillance is lacking and administrative databases are limited, as crash records lack information on pregnancy status and vital records lack data on crash history.

A few studies have addressed these limitations by using linked data sources (i.e., police crash reports and vital records) to estimate state-level pregnancy crash risks (Weiss et al., 2011; Schiff et al., 2010; Hyde et al., 2003). These risks (ranging from 1.0% to 2.8%) are better estimates of crashes during pregnancy, but the denominators do not account for variable time spent driving a motor vehicle during pregnancy. A recent study suggested that these estimates may be on the "lower end of the risk spectrum" since they are from states that have older maternal ages at birth and lower overall severe crash risks in older women (i.e., Washington State, Pennsylvania) or younger maternal ages and lower severe crash risks among younger women (i.e., Utah) (Weiss et al., 2011). The pregnancy-associated crash risks in states, such as North Carolina (NC), that have higher severe crash risks among women of reproductive age are unknown (Weiss et al., 2011).

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Pregnant women are an understudied population in motor vehicle safety research, thus little is known about the characteristics of pregnant drivers in crashes and the circumstances surrounding these crash events. This information is important for informing the development of crash prevention strategies. Our objectives were to use linked data sources in NC to estimate the overall risk of being a pregnant driver in a crash, to estimate crash risks by selected maternal characteristics, and to describe the characteristics of pregnant driver-associated crashes among pregnant women, aged 16–46 years, with singleton pregnancies.

2. Methods

2.1. Study population

This study included a cohort of 878,546 pregnant NC residents, 16–46 years, who reached the 20th week of pregnancy and delivered a singleton infant in NC between January 1, 2001 and December 31, 2008 (Fig. 1). These women were identified from live birth and fetal death records from the NC State Center for Health Statistics (n = 993,274). We removed records for pregnant women aged less than 16 years at the time of delivery (n = 7075) because driver crashes in this pre-licensure age group are uncommon. We also excluded women older than 46 years at delivery (n = 237), and those with multiple gestation pregnancies (n = 33,360). Additional records were excluded (n = 603) if there were missing data for at least one of the following: mother's age, multiple gestation status or gestational age at delivery. Records were also excluded for 73,453 pregnant women who did not meet at least one of the cohort inclusion criteria.

2.2. Probabilistic record linkage

To identify women who were pregnant drivers in crashes, individual vital records were probabilistically linked to state crash records using the following match fields and comparison methods for assigning an agreement weight: mother's first and last name (30% prefix difference allowed), middle name (exact match), date of birth (exact match), race (exact match), and residential county (exact match) (Fig. 1). Linked record pairs were ranked from highest to lowest based on their match weights and probabilities. We specified a false positive rate of 0.01 (or 1%) for the record linkage prior to the study. Matched pairs were selected one-by-one until the desired false positive rate was obtained. There were 103,713 linked vital records and crash reports of which 1037 (1%) were considered false matches. This linkage was performed using LinkSolv generalized linkage software (Strategic Matching Inc., Morrisonville, NY, 2009). After the linkage was completed, the date of the last menstrual period (LMP), gestational age, and the crash date were compared to ensure that the crash occurred during pregnancy. There were 26,913 linked records with crash events that occurred during pregnancy.

2.3. Measures

2.3.1. Motor vehicle crashes and crash severity

Motor vehicle crashes involved a NC licensed female driver of a motor vehicle or passenger truck beyond the 20th week of pregnancy. Crashes are reported by police when they occur on a public roadway and result in a fatality or non-fatal personal injury to any vehicle occupant, total property damage greater than $1000, or property damage of any amount to a vehicle seized. Only crashes involving a NC licensed driver were included because identifiers from the driver license records were needed for the linkage and identifying information for occupants is not available from crash reports.

Crash severity was assessed by police-reported vehicle damage ratings as determined by the direction of impact, type of impact, and damage location (University of North Carolina Highway Safety Research Center, 1984). Severity ratings ranged from 0 (no damage) to 7 (severe damage). For this study, serious or severe crashes were defined as those with a vehicle damage rating of at least 3 (i.e., crashes that resulted in more than minor dents or gouges, such as crumpling of sheet metal and/or deformation of the structure or frame).

2.3.2. Maternal characteristics

Maternal characteristics included gestational age, maternal age, maternal race, Hispanic ethnicity, maternal education, marital status, prenatal tobacco use, prenatal alcohol use, prenatal care before the 20th week, and parity (defined as the total number of prior live births). Gestational age was estimated using the National Center for Health Statistics' method for estimating gestational age in the U.S. vital statistics (Martin, 2007; Wier et al., 2007). Estimates of gestational age relied primarily on LMP, but were edited if necessary. If the LMP date was missing or provided an implausible gestational age (i.e., based on comparing weeks of gestation with birth weight, n = 51,593 or 5.2%), the clinical estimate was used. If the LMP date and clinical estimate were both missing (n = 531, <0.1%), the physician's estimate (i.e., estimated from pregnancy history, early ultrasound, or examination of the stillborn infant), which is only reported on fetal death records, was used. There were 481 records (<0.1%) missing values for all measures of gestational age. Race and Hispanic ethnicity were combined into one measure with four categories, including non-Hispanic (NH) white, NH black, other NH race (i.e., American Indian, Asian, Pacific islander), and Hispanic. Data for these maternal characteristics were obtained from vital records.

2.3.3. Crash characteristics

Crash information included police-reported driver characteristics (i.e., suspected alcohol use at the time of the crash, driver injury, seat belt use), vehicle characteristics (i.e., airbag deployment, estimated speed at impact, vehicle type, number of occupants), and environmental characteristics (i.e., ambient light, crash locality, road surface, and weather). Driver injury was reported by the investigating police officer using a five-point injury severity scale (i.e., KABCO) (ANSI, 2007). Gestational age at the time of the crash was estimated by comparing the date of the crash to the date of delivery.

2.4. Statistical analysis

We used binomial regression to model the risk of being a pregnant driver in a crash after the 20th week of pregnancy and to estimate crash risks for selected maternal characteristics. Since it was impossible to obtain an accurate denominator of pregnancies before 20 weeks due to the lack of information for early fetal losses and terminations in vital records, only pregnancies completing the 20th week and crashes occurring after the 20th week were counted in the analyses. Gestational age-specific crash risks were estimated as the number of pregnant drivers in crashes during two-week periods divided by the total number of women who were pregnant at the beginning of that period. We also conducted descriptive analyses to examine the crash characteristics. This study was approved by the Institutional Review Board of the University of North Carolina at Chapel Hill.

3. Results

3.1. Study population

A total of 878,546 pregnant women met the eligibility criteria in 2001–2008. High proportions of these women were 25–34