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Principal Investigator, Nedra Whitehead

I. Introduction

Injuries from motor vehicle accidents are a leading cause of maternal hospitalization due to maternal trauma and death during pregnancy [1]. Seat belt use reduces the risk of adverse maternal and fetal outcomes[2-6]. The goal of our research was to identify which populations are counseled on seat belt use during prenatal care visits and to test our hypotheses that women counseled on the proper use of a seat belt during pregnancy have less morbidity (measured by length of hospital stay) if they are in a motor vehicle accident than women who are not counseled. The long-term goal of our research was to reduce automobile injury-related morbidity and mortality among pregnant women by providing evidence to public health researchers and clinicians of the importance of counseling women on proper seat belt use and by identifying populations that are not receiving public health education messages on the safety and importance of wearing seat belts during pregnancy. We examined these questions using data from the Pregnancy Risk Assessment Monitoring System (PRAMS). Black women, women who are less than 24 years of age, have less than a high school education, and whose prenatal care was insured through Medicaid are more likely to report being counseled on seatbelt use, are less likely to wear their seatbelts during the last three months of their recent pregnancy, and are more likely to report being injured in a car crash during pregnancy. Prenatal counseling was not associated with the likelihood of being hospitalized or length of hospitalization following a car accident.

II. Review of the Literature

Injuries from motor vehicle accidents are a leading cause of maternal hospitalization due to maternal trauma and death during pregnancy[1]. Motor vehicle accidents also cause a large proportion of fetal deaths, 82% or 2.3 fetal deaths per 100,000 live births, within one 3-year period [7]. Mortality often results from placental abruption, maternal shock, and maternal death [5, 8]. An estimated 2% of live births in the United States are exposed in utero to a police reported motor vehicle crash [3, 7]. Adverse pregnancy outcomes, including preterm labor, low birth weight, and infant respiratory distress syndrome, can occur even in absence of the mother sustaining abdominal injuries [5, 8].

Seat belt use reduces the risk of adverse maternal and fetal outcomes [2-6]. Pregnant women who do not wear a seat belt during a motor vehicle crash are more likely to deliver a low birth weight baby, experience excessive maternal bleeding, and have a resulting fetal death than pregnant women who wore seat belts [3]. Pregnant women who wore a seat belts had the same risk of adverse fetal outcomes as pregnant women who were not in a motor vehicle crash. Lack of information influences seat belt use during pregnancy: pregnant women are unsure of how to correctly wear 3-point safety restraints (shoulder and lap belts) [9] and may believe wearing a seat belt can harm the fetus [10].

The American College of Obstetricians and Gynecologists (ACOG) recommends providers of prenatal care counsel women on seat belt use in pregnancy [11]. ACOG recommends women wear the shoulder belt between the breasts and lap belt low, across the upper thighs [11]. This practice spreads the force of the impact and reduces the risk of injury to the mother and

fetus by preventing strikes to the vehicle's interior fixtures or ejection from the vehicle [12]. Adverse outcomes to the fetus can occur when women wear seat belts across the dome of the abdomen, as is recommended when not pregnant [9, 13-14].

Despite the importance of seat belt use during pregnancy, there is limited data on the prevalence of prenatal counseling on seat belt use, the characteristics of women who receive counseling, and the association of counseling with health outcomes. Data from the Pregnancy Risk Assessment Monitoring System (PRAMS) have found little change in the proportion of women receiving seat belt use counseling; 53% for 14 states in 1997 and 1998 [15], 48% for 19 PRAMS states in 2000 [16], and 48.7% for 22 states in 2001 [17].

These previous studies did not report on the demographic and epidemiologic characteristics of women who did not receive prenatal counseling on seat belt use. Since the potential for being in a motor vehicle crash occurs across all demographic strata, it is also important to note which women are not being counseled during their prenatal visits. Sirin found that 2.3% of women reported being hurt in a car accident during pregnancy [17]. They did not assess the association of being in a motor vehicle crash with seeking medical care,.

III. Study Design and Methods

We conducted a secondary analysis of data from the Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS is a population-based survey of women who recently delivered a live born infant. Participating states are selected through the Centers for Disease Control and Prevention's objective review process. As of October 2009, 38 vital records registry areas (37 states and New York City) participate in the project [18].

This analysis was conducted using data from the 33 states and New York City. These states collected data from 2000 through 2005 and achieved weighted response rates of ≥70%. The population analyzed was restricted to women who received prenatal care counseling. A sub analysis was also be conducted among 3 states that collected data on whether a woman wore her seatbelt during the last 3 months of her recent pregnancy. Vermont and Maryland collected this question from 2001 through 2003 and Utah included the question on their survey from 2004 through 2007.

A stratified, systematic sample of women who have had a recent live birth is drawn from the state's birth certificate file. Mothers who gave birth outside their state of residence and mothers who had a multiple birth greater than three gestations are excluded from the sampling frame. Each participating state samples between 1,300 and 3,400 women per year. Sample design and sampling fractions differ by state and change over time. Birth weight, race, and geographic region are common stratification variables. The data are weighted to account for the sampling design, nonresponses, and noncoverage [19].

The PRAMS survey is a self- administered 14-page standardized questionnaire that collects information on maternal characteristics, behaviors, and experiences that occur several months prior to conception, during pregnancy, and immediately following delivery. The questionnaire has been translated into Spanish for states with sizable Spanish-speaking populations. The PRAMS questionnaire is available on the PRAMS web site (www.cdc.gov/prams).

We estimated the prevalence of receiving prenatal counseling on seat belt usage by women's demographic characteristics. We examined the characteristics of women who reported being in a car crash. We estimated the prevalence of hospitalization and low-birth weight infants among women who reported being in a car crash. We used logistic and linear regression to

determine if counseling on seatbelts is associated with hospitalization. Backward stepwise variable selection was used to determine the best model for the logistic regression. We used the log-likelihood statistics and $\alpha = 0.10$ to compare the full and reduced models. Variables were eliminated if the model including the variable was not significantly better than the model excluding the variable. For categorical variables, the highest prevalence category was used as the reference category. SAS-callable SUDAAN (developed by RTI International, North Carolina) was used for all analyses.

IV. Detailed Findings

Ninety-seven percent [97.4% (95% CI, 97.3, 97.5)] of women received prenatal care and 78.7% (95% CI, 78.39, 78.94) of them initiated care during their first trimester of pregnancy. Slightly less than half (48.5%; 95% CI, 48.2, 48.9) of women who received prenatal care reported being counseled on using seatbelts during pregnancy. Women who were younger, non-white, and had less years of education were more likely to report having that a doctor, nurse, or other health care worker talked with her about using a seatbelt during her pregnancy (Table 1). Women whose prenatal care was paid for by Medicaid or other public program and women received their prenatal care from a public provider also had a higher prevalence of reporting receiving seatbelt counseling (Table 1).

TABLE 1. Characteristics of women who received prenatal counseling for seat belt use during pregnancy, Pregnancy Risk Assessment Monitoring System, 34 U.S. states, 2000-2005.

Characteristic	Risk ratio (unadjusted)	95% CI
Maternal Age (y)		
≤ 17	1.25	1.22 - 1.30
18-24	1.19	1.17 - 1.21
25-29	1.11	1.09 - 1.13
≥ 30	(Referent)	
Maternal race		
Black	1.23	1.22 - 1.25
Asian	1.10	1.07 - 1.14
Other	1.06	0.97 - 1.16
White	(Referent)	
Maternal ethnicity		
Hispanic	1.20	1.18 - 1.22
Non-Hispanic	(Referent)	
Maternal education		
< 12th grade	1.33	1.30 - 1.35
12th grade	1.17	1.15 - 1.18
> 12th grade	(Referent)	
Maternal marital status		
Other	1.19	1.17 - 1.20

Marries	(Referent)	
Parity		
1	1.03	1.01 - 1.04
≥ 2	(Referent)	
Prenatal care payer		
Medicaid or public only	1.21	1.20 - 1.23
No insurance	1.17	1.07 - 1.29
Private insurance	(Referent)	
Prenatal care provider		
Public	1.25	1.23 - 1.27
Private	(Referent)	

Annually, an estimated 32,049 women were injured in a car crash during their pregnancy. PRAMS respondents who were younger, black, had less years of education, and whose prenatal care was paid for by Medicaid or other public program were more likely to report being injured in a car crash during their pregnancy (Table 2).

TABLE 2. Risk Ratios for Self Report of Being in a Car Crash During Pregnancy, by Sociodemographic Characteristics, Pregnancy Risk Assessment Monitoring System, 34 U.S. states, 2000-2005.

Characteristic	**Risk ratio (unadjusted)**	**95% CI**
Maternal Age (y)		
≤ 17	1.76	1.41 - 2.19
18-24	1.91	1.70 - 2.14
25-29	1.22	1.07 - 1.40
≥ 30	(Referent)	
Maternal race		
Black	1.89	1.70 - 2.09
Asian	0.90	0.71 - 1.15
Other	0.71	0.50 - 1.01
White	(Referent)	
Maternal ethnicity		
Hispanic	0.95	0.83 - 1.09
Non-Hispanic	(Referent)	
Maternal education		
< 12th grade	1.55	1.37 - 1.75
12th grade	1.35	1.22 - 1.51
> 12th grade	(Referent)	
Maternal marital status		
Other	1.76	1.60 - 1.93
Marries	(Referent)	
Parity		
1	1.00	0.91 – 1.10
≥ 2	(Referent)	

Prenatal care payer		
Medicaid or public only	1.75	1.59 - 1.92
Private insurance	(Referent)	
Prenatal care provider		
Public	1.27	1.14 - 1.42
Private	(Referent)	

During the six-year study period, an average of 6,108 (56.7%, 95% CI, 51.4, 61.8) women per year, whose only reported injury during pregnancy was a car crash, went to the hospital or emergency room and stayed less than 1 day, and 765 women were hospitalized for at least one day (Table 3). Women whose only reported injury during pregnancy was a car crash had an increased risk of delivering a low birth weight infant (RR: 2.29; 95% CI 1.77, 2.95) (data not shown).

TABLE 3. Annual Medical Care Resulting from a Car Crash. Women with No Other Medical Condition During Pregnancy, Pregnancy Risk Assessment Monitoring System, 33 U.S. states, 2000-2005.

Self-reported care for women in a car crash	**Weighted (n)**	**Percent**	**95% CI**
Total	6,108	100.00	. .
No hospital or bed rest	817	13.37	10.40 - 17.04
Bed rest > 2 days	1,066	17.45	13.71 - 21.95
ED or hospital <1 day	3,461	56.65	51.38 - 61.78
Hospital stay 1-7 days	744	12.17	9.22 - 15.90
Hospital stay >7 days	21	0.35	0.19 - 0.64

We examined the association of prenatal care counseling on seatbelt use with hospitalization due to a car crash and the length of hospitalization due to a car crash. After controlling for factors including age and prenatal care payer, no statistically significant association was found. After adjusting for maternal age and prenatal care payer, women who did not receive counseling were no more likely to be hospitalized [OR: 0.70 (95% CI, 0.38, 1.26)] than those who received counseling. There was also no difference in the length of hospitalization (β= -0.11, p 0.35).

In the three states who asked women if they wore their seatbelts in the last three months of pregnancy,86.8% (95% CI, 86.0, 87.6) women said they wore their seatbelt always, 7.6% (95% CI, 7.0, 8.2) often or almost always, 3.2% (95% CI, 2.8, 3.7) sometimes, 1.5% (95% CI, 1.2, 1.8) rarely, and 1.0% (95% CI, 0.7, 1.2) never. Women who were older, Non-Hispanic white, had greater than 12 years of education, and whose prenatal care was paid for by private insurance were most likely to report wearing their seatbelts always or often during the last three months of pregnancy (Table 4).

TABLE 4. Characteristics of women who reported wearing their seatbelts during the last 3 months of pregnancy always and often compared with those who wore it sometimes, rarely, or never, Pregnancy Risk Assessment Monitoring System, 3 U.S. states, 2000-2007.

Characteristic	Risk ratio (unadjusted)	95% CI
Maternal Age (y)		
≤ 17	0.86	0.80 - 0.92
18-24	0.96	0.94 - 0.97
25-29	0.99	0.98 - 1.00
≥ 30	(Referent)	
Maternal race		
Black	0.97	0.95 - 1.00
Asian	1.03	1.02 - 1.05
White	(Referent)	
Maternal ethnicity		
Hispanic	0.98	0.96 - 1.01
Non-Hispanic	(Referent)	
Maternal education		
< 12th grade	0.90	0.88 - 0.93
12th grade	0.94	0.93 - 0.95
> 12th grade	(Referent)	
Maternal marital status		
Other	0.91	0.89 - 0.92
Marries	(Referent)	
Parity		
1	1.01	0.99 - 1.02
≥ 2	(Referent)	
Prenatal care payer		
Medicaid or public only	0.94	0.93 - 0.96
Private insurance	(Referent)	
Prenatal care provider		
Public	0.96	0.94 - 0.98
Private	(Referent)	

V. Discussion and Interpretation of Findings

About one half of pregnant women report being counseled on seatbelt use. Women who are black, less than 24 years of age, have less than a high school education, and whose prenatal care was insured through Medicaid are more likely to report being counseled on seatbelt use, are less likely to wear their seatbelts during the last three months of their recent pregnancy, and are more likely to report being injured in a car crash during pregnancy (Tables 1, 2 and 4). In the 34 states included in this analysis, approximately 2% of women reported an injury due to a car crash during their pregnancy (Table 3), which is similar to previous reports [3, 20]. Among women whose

only reported injury was from a car crash, 86.6% of the women sought care at the emergency department, were hospitalized, or were advised to bed rest. Prenatal counseling was not associated with the likelihood of being hospitalized or length of hospitalization following a car accident.

Our study has some limitations. Data collection is retrospective, and for some women, the recall period may be as long as 15 months. Women may not recall whether they received counseling on seat belt use or may misreport a car accident occurred before or after their pregnancy. Previous studies have differed in their findings of the validity of maternal recall of pregnancy and prenatal care events. Tilley, Barnes et al. [21]found women to have a good to excellent recall of personal medical history, however, recall of medical procedures was poor; Githen, Glass et al. [22] found women had high perinatal recall for periods as high as 4 to 6 years. Additionally, patients and their providers may disagree in their recall of services provided [23-24]. Also, due to the PRAMS question format, the specific content of the counseling received is not known.

We also could not determine when in the pregnancy the motor vehicle crash occurred. Therefore, we could not tell whether the prenatal counseling occurred before or after the motor vehicle crash. This may explain why we found a negative (though non-significant) association between counseling and hospitalization: Women may have been counseled on seatbelt use as a result of being in a car crash.

We do not have any direct information on factors related to the crash which may have affected hospitalization, such as the severity of the crash, airbag deployment, the injuries received, or treatment required. Therefore, we are not able to examine how airbag deployment modifies the effect of counseling on seat belt use. A dummy simulated study found that when the dummy was unbelted, a substantial increase was seen in the fetal head injury criteria with airbag deployment [12]. Case reports of adverse fetal outcomes among belted moms in crashes where an airbag deployed indicate mixed results, with three reports of no adverse effect on the fetus and two of an adverse event [25-26]. Thus, airbag deployment is not likely to bias our results.

And lastly, due to the wording of the injury question, we cannot determine whether the mother was a pedestrian or passenger of a motor vehicle if she indicates being in a car crash. We would expect most reports to be of accidents where the woman was an occupant of the vehicle, however. According to nationally representative sample of daily and long-distance travel behaviors, the rate of injury for a female vehicle passenger is five times that of a female pedestrian [27].

Almost all women in the United States, 97.4%, receive prenatal care; 83.9% of women in 2004 began care in the first trimester [28]. Consequently, health care providers have an opportunity to reduce the burden of motor vehicle crash injury by providing counseling during prenatal visits on the safe use of seatbelts during pregnancy. A retrospective cohort study found that women who were injured in the first 24 weeks of pregnancy had a higher risk of preterm delivery, which highlights the importance of women being counseled on seatbelt use early in their pregnancy [29].

Proper positioning of the seatbelt is an important topic to address for two reasons: when worn incorrectly, seatbelts have been reported to be associated with fetal injury and because patients who receive information on the proper positioning are significantly more likely to wear their seatbelts correctly [8]. The ACOG recommends pregnant women be counseled to wear seatbelts in the following manner: both lap belt and shoulder belts should be worn; the lap belt placed below the abdomen, over the anterior superior iliac spine and pubic symphysis; the

shoulder harness positioned between the breasts; and there should not be excessive slack in either the lap or shoulder belts [11].

PRAMS data can provide some additional information on the value of seat belt use during pregnancy, most notably on the association between counseling on seat belt use and reported use of seat belts. PRAMS utility in this area is limited by the its retrospective (to birth) data collection and the relatively small proportion of women who experience a car crash during pregnancy. A prospective study is needed to determine if educating pregnant women on the proper use of seat belts during pregnancy improves maternal and fetal outcomes or reduces health care utilization among women who experience a motor vehicle crash during pregnancy.

VI. List of products

Produced during this grant period

Peer-reviewed articles

O'Neil ME, Beck LF, Whitehead, NS. Prenatal counseling on seat belt use and motor vehicle crash-related hospitalizations among pregnant women. *In CDC clearance.*

Presentations

O'Neil, M.E., & Whitehead, N.S. (2009, June). Prenatal counseling on seatbelts and reported hospitalizations among pregnant women. Poster presented at Society for Pediatric and Perinatal Epidemiology, Anaheim, CA. (Copy attached)

O'Neil, M.E., & Whitehead, N.S. (2008, October). Prenatal Counseling on Seatbelts and Reported Hospitalizations among Pregnant Women. Poster presented at 2008 Conference of the American Public Health Association, San Diego, CA.

Educational Materials

Seat Belt Use During Pregnancy (for physicians). Copy attached. Printed copies were provided to the Centers for Disease Control and Prevention's Division of Reproductive Health and the Division of Unintentional Injury Prevention. Distributed at the 2009 MCH Epidemiology Conference, Tampa FL, December 9 -11, 2009 and by CDC at an Injury conference in January. Posted at www.rti.org and copies submitted to MCHB.

Seat Belt Use During Pregnancy (for pregnant women). Printed copies were provided to the Centers for Disease Control and Prevention's Division of Reproductive Health and the Division of Unintentional Injury Prevention. Posted at www.rti.org.

Planned Follow up Analyses

Ms. O'Neil plans to conduct the following analyses on this topic:

- Association between counseling on seat belt use and reported seat belt use
- Association of car crash and pregnancy outcomes, and modification by counseling on seat belt use.

References

1. Weiss HB. The epidemiology of traumatic injury-related fetal mortality in Pennsylvania, 1995-1997: the role of motor vehicle crashes. *Accid Anal Prev* 2001;33(4):449-54.
2. Haapaniemi P. Women's highway deaths on the rise *Traffic Safety* 1996;96:6-11.
3. Hyde LK, Cook LJ, Olson LM, Weiss HB, Dean JM. Effect of motor vehicle crashes on adverse fetal outcomes. *Obstet Gynecol* 2003;102(2):279-86.
4. Klinich KD, Flannagan CA, Rupp JD, Sochor M, Schneider LW, Pearlman MD. Fetal outcome in motor-vehicle crashes: effects of crash characteristics and maternal restraint. *Am J Obstet Gynecol* 2008;198(4):450 e1-9.
5. Schiff MA, Holt VL. Pregnancy outcomes following hospitalization for motor vehicle crashes in Washington State from 1989 to 2001. *Am J Epidemiol* 2005;161(6):503-10.
6. Wolf ME, Alexander BH, Rivara FP, Hickok DE, Maier RV, Starzyk PM. A retrospective cohort study of seatbelt use and pregnancy outcome after a motor vehicle crash. *J Trauma* 1993;34(1):116-9.
7. Weiss HB, Songer TJ, Fabio A. Fetal deaths related to maternal injury. *JAMA* 2001;286(15):1863-8.
8. Chames MC, Pearlman MD. Trauma during pregnancy: outcomes and clinical management. *Clin Obstet Gynecol* 2008;51(2):398-408.
9. Tyroch AH, Kaups KL, Rohan J, Song S, Beingesser K. Pregnant women and car restraints: beliefs and practices. *J Trauma* 1999;46(2):241-5.
10. McGwin G, Jr., Russell SR, Rux RL, Leath CA, Valent F, Rue LW. Knowledge, beliefs, and practices concerning seat belt use during pregnancy. *J Trauma* 2004;56(3):670-5.
11. ACOG educational bulletin. Obstetric aspects of trauma management. Number 251, September 1998 (replaces Number 151, January 1991, and Number 161, November 1991). American College of Obstetricians and Gynecologists. *Int J Gynaecol Obstet* 1999;64(1):87-94.
12. Pearlman MD, Viano D. Automobile crash simulation with the first pregnant crash test dummy. *Am J Obstet Gynecol* 1996;175(4 Pt 1):977-81.
13. Bunai Y, Nagai A, Nakamura I, Ohya I. Fetal death from abruptio placentae associated with incorrect use of a seatbelt. *Am J Forensic Med Pathol* 2000;21(3):207-9.
14. Pearlman MD, Phillips ME. Safety belt use during pregnancy. *Obstet Gynecol* 1996;88(6):1026-9.
15. Petersen R, Connelly A, Martin SL, Kupper LL. Preventive counseling during prenatal care: Pregnancy Risk Assessment Monitoring System (PRAMS). *Am J Prev Med* 2001;20(4):245-50.
16. Beck LF, Gilbert BC, Shults RA. Prevalence of seat belt use among reproductive-aged women and prenatal counseling to wear seat belts. *Am J Obstet Gynecol* 2005;192(2):580-5.

17. Sirin H, Weiss HB, Sauber-Schatz EK, Dunning K. Seat Belt use, Counseling and Motor-Vehicle Injury During Pregnancy: Results from a Multi-State Population-Based Survey. *Matern Child Health J* 2007;11(5):505-10.

18. CDC. Monitoring progress toward achieving maternal and infant Health People 2010 objectives - 19 states, Pregnancy Risk Assessment Monitoring System (PRAMS), 2000-2003. In: CDC Surveillance Summaries, October 6, 2006. MMWR 2006;55(No. SS-9). 2006.

19. CfDCaP. 04 Sampling v4.1. In: *PRAMS Model Protocol 2008 Version*. Atlanta, GA: Centers for Disease Control and Prevention; 2008.

20. Weiss HB, Strotmeyer S. Characteristics of pregnant women in motor vehicle crashes. *Inj Prev* 2002;8(3):207-10.

21. Tilley BC, Barnes AB, Bergstralh E, et al. A comparison of pregnancy history recall and medical records. Implications for retrospective studies. *Am J Epidemiol* 1985;121(2):269-81.

22. Githens PB, Glass CA, Sloan FA, Entman SS. Maternal recall and medical records: an examination of events during pregnancy, childbirth, and early infancy. *Birth* 1993;20(3):136-41.

23. Richards SH, Coast J, Peters TJ. Patient-reported use of health service resources compared with information from health providers. *Health Soc Care Community* 2003;11(6):510-8.

24. Sciamanna CN, Goldstein MG, Marcus BH, Lawrence K, Pinto BM. Accuracy of recall of exercise counseling among primary care patients. *Prev Med* 2004;39(6):1063-7.

25. Fusco A, Kelly K, Winslow J. Uterine rupture in a motor vehicle crash with airbag deployment. *J Trauma* 2001;51(6):1192-4.

26. Sims CJ, Boardman CH, Fuller SJ. Airbag deployment following a motor vehicle accident in pregnancy. *Obstet Gynecol* 1996;88(4 Pt 2):726.

27. Beck LF, Dellinger AM, O'Neil ME. Motor vehicle crash injury rates by mode of travel, United States: using exposure-based methods to quantify differences. *Am J Epidemiol* 2007;166(2):212-8.

28. Hamilton BE, Martin JA, Ventura SJ. Births: preliminary data for 2005. *Natl Vital Stat Rep* 2006;55(11):1-18.

29. Weiss HB, Sauber-Schatz EK, Cook LJ. The epidemiology of pregnancy-associated emergency department injury visits and their impact on birth outcomes. *Accid Anal Prev* 2008;40(3):1088-95.