Journal of Safety Research 70 (2019) 13–17

Contents lists available at ScienceDirect

Journal of Safety Research

journal homepage: www.elsevier.com/locate/jsr

Short Communication

Nighttime seat belt use among front seat passengers: Does the driver's belt use matter?

Kwaku F. Boakye, [a,*] Ruth A. Shults, [b] Jerry D. Everett [a]

[a] Center for Transportation Research, University of Tennessee – Knoxville, 600 Henley Street, 309 Conference Center Building, Knoxville, TN 37996-4133, USA
[b] Division of Unintentional Injury Prevention, Centers for Disease Control, Atlanta, GA 30030, USA

ARTICLE INFO

Article history:
Received 6 November 2018
Received in revised form 27 March 2019
Accepted 15 April 2019
Available online 02 May 2019

Keywords:
Seat belt
Nighttime
Driver
Right-front passenger
Test of proportions

ABSTRACT

Introduction and Method: We explored the relationship between nighttime seat belt use of right-front passengers and their drivers using observational data from 33,310 vehicles in east Tennessee during March 2015 – May 2017. *Results:* Overall, nighttime passenger seat belt use varied by 50 percentage points from 92% when drivers were belted to 42% when drivers were not belted, suggesting that part-time seat belt users can be heavily influenced by the seat belt status of their traveling companions. When stratified by vehicle type and sex, passenger seat belt use by driver seat belt status varied as much as 74 percentage points from 96% to 22%. Passenger seat belt use was typically lower when riding with unbelted same-sex drivers than when riding with unbelted drivers of the opposite sex. Conclusions and Practical Applications: This finding suggests that the role of peer influence in decision-making about seat belt use may differ depending on the sex of a vehicle driver and his or her passengers. Further research is warranted to explore this finding as well as other social and cultural influences that have not been fully examined in seat belt research.

1. Introduction

When properly fastened, seat belts are estimated to reduce fatal injuries to front seat car passengers by 45% and moderate-to-critical injuries by 50% (National Center for Statistics and Analysis, 2018a). In 2016, seat belt use in the United States (U.S.) was estimated to be 90% (Li & Pickrell, 2018). However, among fatally injured vehicle occupants with known restraint use in 2016, 41% were unrestrained in daytime crashes and 56% were unrestrained in nighttime crashes (National Center for Statistics and Analysis, 2018a).

Several studies have identified factors that likely contribute to lower nighttime seat belt use. Motorists may believe that they are less likely to be cited by law enforcement for not wearing a seat belt during nighttime hours (Kulanthayan, Law, Raha, et al., 2004). Moreover, the nighttime traveling population often differ significantly from daylight hours, with fewer high-use populations like parents with children and older adults but more of those who tend to engage in risk-taking behaviors like speeding, impaired driving, and non-use of seat belts (Kim & Kim, 2003; Kulanthayan et al., 2004). In light of the high prevalence of unbelted fatalities, particularly at night, enhanced strategies to increase seat belt use are needed.

Understanding the factors that impact seat belt use is critical for developing effective interventions. Existing literature indicates that several factors including socio-demographics (e.g., age, gender, race, education, economic status, etc.) (Begg & Langley, 2000; Lipovac, Tešić, Marić, et al., 2015; Şimşekoğlu & Lajunen, 2008), interpersonal and social factors (e.g., presence and seat belt use of other passengers, seating position, seat belt laws and enforcement, etc.) (Chaudhary, Solomon, & Cosgrove, 2004; Nambisan & Vasudevan, 2007; Williams & Shabanova, 2002), and environmental factors (e.g., weather, traffic condition, time of day, rural/urban location, vehicle type, etc.) (Bhat, Beck, Bergen, et al., 2015; Boakye, Khattak, Everett, et al., 2018; Gkritza & Mannering, 2008) affect seat belt use.

With regard to interpersonal factors, studies have demonstrated that seat belt use varies strongly by passenger presence and age. For example, Williams and Shabanova (2002) found that seat belt use among teenage drivers was higher when parents or older adults accompany them but lower when accompanied by their peers. In the same study, seat belt use of teenage drivers was found to decrease with increasing number of passengers, whereas for older drivers, the usage increased with passenger presence. Other studies have also shown that front-seat passengers' seat belt use is highly correlated with drivers' seat belt use during daytime hours – when drivers wear seat belts, their accompanying passengers are more likely to use seat belts and when drivers do not wear seat belts, their passengers are more likely not to wear as well (Gkritza & Mannering, 2008; Han, 2017; Nambisan & Vasudevan, 2007). A separate analysis conducted recently on a portion of the data used in the current study showed that front-seat passengers traveling at night with unbelted drivers are at 14 times the odds of being

* Corresponding author.
E-mail addresses: kboakye@vols.utk.edu (K.F. Boakye), jeverett@utk.edu (J.D. Everett).

https://doi.org/10.1016/j.jsr.2019.04.004
0022-4375/

unbelted compared to those riding with a belted driver (Boakye et al., 2018).

We previously examined factors associated with passengers' seat belt non-use at night with the objective of demonstrating the application of Generalized Estimating Equation (GEE) in addressing the clustering or correlation effects associated with roadside observations (Boakye et al., 2018). In this current study, we further examine the relationship between front-seat passengers' seat belt use and that of their drivers at night. To the authors' knowledge, this study is the first to explore how front-seat passengers' seat belt use at night varies among same-sex occupant pairs and opposite-sex pairs of passengers and their drivers.

Data were collected during observational surveys conducted in east Tennessee as part of a pilot intervention aimed at improving nighttime seat belt use (Boakye, 2017). Tennessee has a primary enforcement seat belt law that applies to all front seat occupants (Tennessee Code §55-9-603); law enforcement officers may stop a vehicle and issue a citation solely for nonuse of a seat belt. Tennessee's average daytime seat belt use rate in 2016 was 89%, which was higher than in any previous year (Pickrell, 2017).

2. Methods

2.1. Study sample selection

A five-county region of east Tennessee was selected for this study because the area's sociodemographic characteristics are similar to those of the entire state's population, the mix of urban and rural settings, and the strength of existing partnerships between the Center for Transportation Research at the University of Tennessee and key community groups and stakeholders. We selected 36 roadway sites at which to observe nighttime front-seat seat belt use from the 59 sites used for annual daytime seat belt observational surveys in the five-county study area (Blount, Knox, Loudon, Roane, and Sevier) for the past decade (see Fig. 1).The annual surveys are conducted in every state in coordination with the National Highway Traffic Safety Administration (National Center for statistics and Analysis, 2018b). The sample design used for the annual daytime observations in each state follows the "The Uniform Criteria for State Observational Surveys of Seat Belt Use (23 CFR Part 1340)." For site selection, a multi-stage area probability sampling approach is utilized. In the first stage, 16 of the 95 Tennessee counties are selected to achieve a national desired level of accuracy in belt use estimation. The 16-county sample is chosen using a two-step procedure. First, the four largest counties, then, 12 additional counties are selected using "population weighting" and random number generation method. In the second stage, sampling of individual route segments (ranging in length from 0.5 to 5 miles) in each of the counties is performed. For each county, segments are randomly chosen with probability of selection proportional to the segment's annual Vehicle Miles Traveled (VMT). The qualifying route segments from each of the survey counties are stratified into four groupings (Interstates/Freeways/Expressways; Other Principal Arterials; Minor Arterials; and Collectors) using Enhanced Tennessee Roadway Information Management System (ETRIMS) functional classification method. The number of segments chosen from each stratum is proportional to each county's estimated annual VMT. This sampling design assures that the final sample is

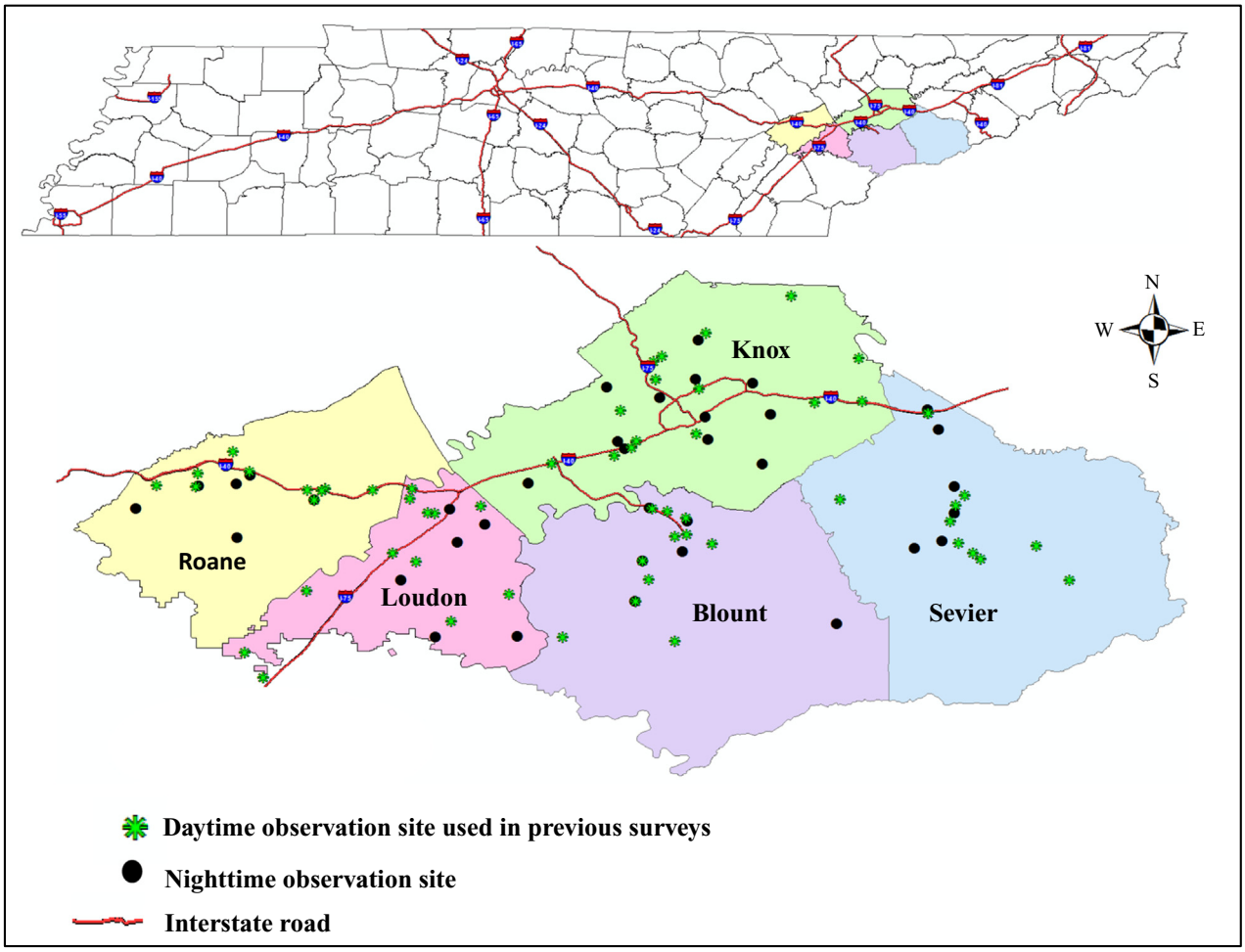

Fig. 1. Nighttime observation sites in five counties around the Knoxville area.

representative of the traffic mix in the county across the roadway functional types.

The feasibility of conducting night observations at each site was the primary factor considered in selecting sites. Six sites from each of the five counties and six additional sites from the central business district of Knoxville (in Knox County) were selected. The selected sites were either at the same location or at different spot but along the same route segment where daytime observations are made. Once selected, each of the 36 sites was randomly linked to one of six possible observation periods (8–9 pm, 9–10 pm, 10–11 pm, 11 pm–12 am; 12–1 am; 1–2 am) for all days of the week. Therefore, the sampling design was stratified by both location (per county) and time period for observations.

2.2. Data collection

The Center for Transportation Research at The University of Tennessee conducted a series of 17 nighttime seat belt observational survey waves (unevenly spaced) over a 27-month period during March 2015–May 2017. The data collection techniques followed the nighttime observation guidelines developed by the National Highway Traffic Safety Administration (NTHSA) (Chaudhary, Leaf, Preusser, et al., 2010). Data were collected at the 36 selected sites in five counties of east Tennessee (see Fig. 1). This five-county region comprised the study area for the pilot intervention. Surveys were conducted before and after periodic seat belt use campaign waves (i.e., saturation patrols, check points and Click-It-Or-Ticket enforcement campaigns combined with paid or earned media and public outreach programs) (Boakye, 2017).

At each survey site, observations lasted for one to two hours depending on the level of traffic volume. Illumination was enhanced using a portable, low-beam lighting fixture where needed. Data were typically collected by two trained Center for Transportation Research staff members, one making seat belt observations and the other recording the results as stated by the observer. The data collected included shoulder belt use of the driver and right-front seat passenger (yes, no, or unsure), sex of both occupants (male or female), and type of vehicle (passenger car, sport-utility vehicle (SUV), pickup truck, or minivan). Seat belt use was recorded as "unsure" in <3% of the entire data set.

2.3. Analysis

Data from all 36 survey sites were combined for analysis. Of the 101,328 vehicles observed during the entire study period, 33% (33,310) had both a driver and right-front seat passenger. Seat belt use proportions were separately calculated for passengers and drivers. Although overall passenger seat belt use varied from 83% in 2015 to 87% in 2016 and 86% in 2017, the associations between passenger seat belt use and the other study factors (i.e., occupants' sex, driver seat belt status, vehicle type) remained stable over the 27-month study period. Therefore, we combined the data from all three years for analysis.

Ignoring the study's two-stage area probability sample design in the analysis could bias findings related to seat belt use (Bell, Ene, Smiley, Ene, et al., 2014; Bell, Ene, Smiley, & Schoeneberger, 2013). To test this possibility, we constructed two logistic models; a single level model and a two-level multivariate model with front-seat passengers at level 1 and observation sites at level 2. Although the results indicated variation in passenger seat belt use across sites, the magnitude, direction and significance level of the explanatory variables of interest in both the single and the two-level models remained essentially unchanged as shown in Table 1. Therefore, ignoring the sampling design, we conducted a descriptive, bivariate analysis using Z-tests of proportions to explore in depth how nighttime passenger seat belt use varied by each of the study factors. Statistical significance was set at P-value <.05.

3. Results

Overall, nighttime passenger seat belt use averaged 86% but varied from 92% when drivers were belted to 42% when drivers were not belted (Table 2). Seat belt use among male passengers averaged 10 percentage points lower than use among female passengers (79% vs. 89%). Comparing seat belt use by vehicle type, pickup truck passengers averaged about 10 percentage points lower than passengers in other vehicle types (77% vs. 87% or 88%).

3.1. Seat belt use of right-front seat passengers based on drivers' seat belt use

Table 3 presents passenger seat belt use under three conditions: passenger belt use without regard to driver use (total); passenger belt use when their driver was belted; and passenger belt use when their driver was not belted. Compared to passenger belt use without regard to driver belt use, passenger belt use was significantly higher when their driver was belted and significantly lower when their driver was not belted. These results were consistent across all the vehicle types regardless of the sex of the drivers and passengers.

Comparing seat belt use by sex and type of vehicle, belt use among male passengers ranged from a low of 22% when riding in pickup trucks with unbelted male drivers to a high of 91% when riding in vans or SUVs

Table 1
Comparison of single-level and multi-level (two-level) models, nighttime passenger seat belt use, East Tennessee, March 2015–May 2017.

Parameters	Categories	Single-level model			Two-level model*		
		Estimate	Standard Error	P-value	Estimate	Standard Error	P-value
Fixed parameters							
Intercept		0.456	0.008	<0.001	0.455	0.008	<0.001
Passenger sex	Male	−0.081	0.004	<0.001	−0.080	0.004	<0.001
	Female	–	–	–	–	–	–
Driver sex	Male	0.014	0.004	<0.001	0.014	0.004	<0.001
	Female	–	–	–	–	–	–
Driver belt use	Belted	0.493	0.005	<0.001	0.491	0.005	<0.001
	Unbelted	–	–	–	–	–	–
Vehicle type	Car	−0.004	0.006	0.4746	−0.003	0.006	0.571
	Pickup truck	−0.038	0.007	<0.001	−0.038	0.007	<0.001
	SUV	0.006	0.006	0.327	0.006	0.006	0.345
	Minivan	–	–	–	–	–	–
Random parameter							
	Level 2 variance	NA	NA	NA	0.0002	0.0001	0.007
	Level 1 variance	0.0912	0.0007	<0.0001	0.0911	0.0007	<0.0001

NA = not applicable (−) = referenced category.

* PROC MIXED model estimated using maximum likelihood (ML), Kenward-Roger degrees of freedom and covariance structure type = variance component (VC). Intraclass Correlation Coefficient (ICC) = 0.00674, indicating that the sites account for less than 1% of the total variation in passenger seat belt use.

Table 2
Nighttime passenger seat belt use, East Tennessee, March 2015–May 2017.

Variable	Category	No. passengers	Passenger seat belt use (%Yes)	Chi-square test P-value
Year	2015	11,438	83	< 0.001
	2016	14,120	87	
	2017	7752	86	
Driver seat belt use	Yes	28,822	92	< 0.001
	No	4488	42	
Passenger sex	Male	11,775	79	< 0.001
	Female	21,535	89	
Vehicle type	Car	14,650	87	< 0.001
	Pickup	5459	77	
	SUV	10,073	88	
	Van	3128	87	
Driver sex	Male	22,172	86	0.700
	Female	11,138	86	

with male belted drivers. Seat belt use for female passengers ranged from 22% when riding in pickup trucks with unbelted female drivers to 96% when riding in vans with belted male drivers or riding in SUVs with belted female drivers.

Every Z-test for difference in proportions comparing passenger seat belt use without regard to driver seat belt (total) to passenger seat belt use with regard to driver seat (either "with belted driver" or "with unbelted driver") was statistically significant at P-value <.05.

Comparing same-sex occupant pairs with opposite-sex pairs, when passengers and drivers were of the same sex and the driver was unbelted, passenger seat belt use was almost always lower than when the occupants were of opposite sex and the driver was unbelted. For example, for all types of vehicles combined, male passenger belt use was 27% when riding with unbelted male drivers and 33% when riding with unbelted female drivers. Similarly, female passenger belt use was 40% when riding with unbelted female drivers and 53% when riding with unbelted male drivers.

Table 3
Nighttime passenger seat belt use by driver seat belt use, East Tennessee, March 2015–May 2017.

Driver sex	Vehicle type	Passenger sex	Passenger seat belt use					
			Total		With belted driver		With unbelted driver	
			N	% SB	N	% SB	N	% SB
Male	Car	Male	2404	81	2043	89	361	33
		Female	6643	90	5907	94	736	56
	Pickup	Male	1750	65	1186	86	564	22
		Female	3094	83	2404	94	690	46
	SUV	Male	1350	82	1143	91	207	31
		Female	5008	91	4399	95	609	56
	Van	Male	431	80	350	91	81	33
		Female	1492	90	1294	96	198	57
	All	Male	5935	76	4722	89	1213	27
		Female	16,237	89	14,004	95	2233	53
Female	Car	Male	2928	83	2656	88	272	35
		Female	2675	90	2455	94	220	40
	Pickup	Male	398	73	325	83	73	29
		Female	217	82	180	94	37	22
	SUV	Male	1876	83	1697	89	179	26
		Female	1839	91	1691	96	148	43
	Van	Male	638	82	570	86	68	49
		Female	567	88	522	91	45	49
	All	Male	5840	82	5248	88	592	33
		Female	5298	90	4848	94	450	40
All	Car	Male	5332	82	4699	88	633	34
		Female	9318	90	8362	94	956	52
	Pickup	Male	2148	67	1511	86	637	22
		Female	3311	83	2584	94	727	45
	SUV	Male	3226	83	2840	90	386	28
		Female	6847	91	6090	96	757	54
	Van	Male	1069	81	920	88	149	40
		Female	2059	90	1816	94	243	55
	All	Male	11,775	79	9970	88	1805	29
		Female	21,535	89	18,852	95	2683	51

N = total number of passengers observed.
% SB = percent of passengers observed wearing seat belts.

3.2. Study limitations

The seat belt use data were collected as part of a pilot intervention that had varying levels of intensity over time and location, which may have impacted seat belt use. Although seat belt use varies by age, we did not attempt to estimate occupants' age. The study was limited to front seat occupants. Also, data were collected until 2 a.m.; seat belt use rates after 2 a.m. might have been different. Finally, east Tennessee was selected for this study in part because the region's mix of roadway types and population demographics are similar to those of the entire state. Therefore, the study's findings may not be generalizable to other states or jurisdictions.

4. Discussion

Our findings indicate that even in a state with a primary enforcement law and relatively high seat belt use, many motorists must be part-time belt users. Overall, nighttime passenger seat belt use varied by 50 percentage points from 92% when drivers were belted to 42% when drivers were unbelted. This finding suggests that part-time seat belt users might be heavily influenced by the seat belt status of their traveling companions. Passenger seat belt use was typically lower when riding with unbelted same-sex drivers (e.g., female passenger and female driver) than when riding with unbelted drivers of the opposite sex. This finding suggests that the role of peer influence in decision-making about seat belt use may differ depending on the sex of a vehicle driver and his or her passengers. Further research is warranted to explore this finding as well as other social and cultural influences that are not traditionally examined in seat belt research (Jans, Aremia, Killmer, et al., 2015). Our findings also confirm results from existing seat belt use literature (Bhat et al., 2015; Chaudhary & Preusser, 2006; Şimşekoğlu & Lajunen, 2008a), including lower belt use among males and occupants of pickup trucks.

Converting part-time seat belt users to full-time users could greatly reduce traffic fatalities and serious injuries. Behavioral theory research offers insights for designing persuasive messaging that might prove beneficial with part-time seat belt users (Jans et al., 2015; Lewis, Watson, White, et al., 2013; Lewis, White, Ho, et al., 2017; Şimşekoğlu & Lajunen, 2008b; Stasson & Fishbein, 1990). For example, intention to wear a seat belt has been found to be related to a person's beliefs about whether significant others think he/she should buckle up (i.e., subjective norms) and issues of comfort and convenience. These findings led to recommendations to correct false perceptions of subjective norms and emphasize advantages of seat belt use instead of the possible negative outcomes of not buckling up (Jans et al., 2015; Şimşekoğlu & Lajunen, 2008b; Stasson & Fishbein, 1990). Similarly, research into persuasive messaging aimed at reducing speeding among young males recommends using positive emotional appeals focusing on shared responsibility and prioritizing the safety of significant others (Lewis et al., 2013; Lewis et al., 2017). Integrating such theory-based, persuasive messaging into multifaceted interventions that specifically target part-time seat belt users could help advance the science of occupant safety.

Acknowledgements

This paper is supported in part by Cooperative Agreement Number, 1 U01CE002503-01, funded by the Centers for Disease Control and Prevention (CDC). We also thank the Tennessee Highway Safety Office for partially funding the efforts of this research.

The authors express their sincere gratitude to Professor Shashi Nambisan for his insights and expertise that greatly contributed to this research. We are extremely grateful to students and staff at the University of Tennessee in conducting the nighttime seat belt surveys. We thank the five-county police departments for their random patrols to check on observers' safety during the study.

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