Cervical vertebral and spinal cord injuries remain overrepresented in rollover occupants[1]

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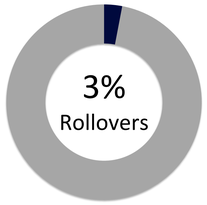
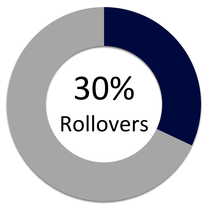
INTRODUCTION

Passenger vehicle **crashes**



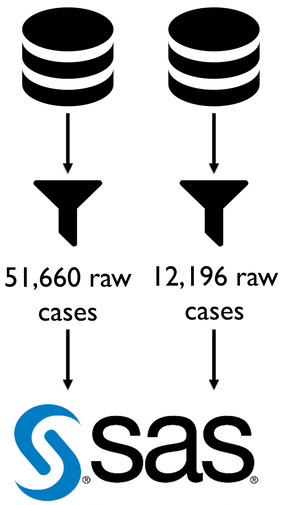
Passenger vehicle crash **fatalities**



- Rollover crashes continue to be a substantial public health issue in North America[2].
- Previous research has shown that the cervical spine is the most injured spine segment in rollovers[3], but much of the past research has focused on risk factors rather than the actual cervical spine injuries.
- We sought to examine how different types of cervical spine injuries (vertebral and/or cord injury) vary with different occupant-related factors in rollovers and to compare these with non-rollovers.

METHODS AND MATERIALS

NASS-CDS (2005-2015) CISS* (2017-2022)



*) for vehicles newer than 2010

Separated cases into occupants with:

1. Cervical Vertebral Injuries (VI)
2. Cervical Spinal Cord Injuries (CI)
3. All Injuries: VI+CI (with duplicates removed)

Descriptive Statistics for rate and proportions.

Relative Risk to compare rollovers and non-rollovers:

$$RR = \frac{\left(\frac{N_{rollover}^{injured}}{N_{rollover}^{all}}\right)}{\left(\frac{N_{nonrollover}^{injured}}{N_{nonrollover}^{all}}\right)}$$

Test of interaction to compare relative risks at a significance level of $\alpha \leq 0.05$.

KEY RESULTS

1. Most occupants with cervical spine injuries in rollover crashes had only vertebral injuries (91 to 94%) without cord involvement.
2. Cervical spine injuries involving vertebral fractures were 5.2 times (NASS-CDS) to 6.4 times (CISS) more likely to occur in rollover crashes than in non-rollover crashes (Table 1).
3. Despite accounting for only 7.3% (5.5% in CISS) of collisions, rollovers generated 23% (15%) of cervical spinal cord injuries and 28% (28%) of cervical vertebral injuries.
4. Even in a newer vehicle fleet, rollover risks for cervical spine injuries remained disproportionally high (Table 2).

TABLES AND FIGURES[1]

Table 1. CISS (2017-2022) and NASS-CDS (2005-2015) proportions and relative risks between rollovers and non-rollovers for all exposed occupants (and subgroups) separated by Injury Group (VI: vertebral injury, CI: cord injury). Table summarizes the proportion and the relative risk (95th percentile confidence interval) of each injury type.

	CISS (2017-2022)						NASS-CDS (2005-2015)					
Injury Group	VI		CI		All-Injuries		VI		CI		All-Injuries	
All Occupants	6.55	(2.18 - 19.71)	3.04	(0.64 - 14.41)	6.36	(2.21 - 18.33)	5.16	(3.44 - 7.74)	3.75	(1.82 - 7.74)	5.00	(3.46 - 7.23)
Females	11.52	(2.64 - 50.31)	-	-	10.62	(2.49 - 45.27)	5.48	(2.37 - 12.65)	3.47	(1.48 - 8.13)	5.36	(2.38 - 12.07)
Males	2.75	(1.38 - 5.48)	4.56	(0.92 - 22.63)	3.12	(1.68 - 5.80)	5.01	(3.63 - 6.91)	3.47	(1.44 - 8.35)	4.78	(3.51 - 6.49)
Belted	9.12	(2.32 - 35.82)	2.40	(0.44 - 13.12)	8.58	(2.22 - 33.13)	3.82	(2.05 - 7.11)	4.61	(2.16 - 9.85)	3.83	(2.12 - 6.91)
Unbelted	2.23	(1.13 - 4.41)	2.94	(0.43 - 20.06)	2.43	(1.25 - 4.74)	4.81	(2.20 - 10.50)	4.49	(1.43 - 14.09)	4.72	(2.13 - 10.48)
Ejected	1.17	(0.29 - 4.73)*	0.71	(0.03 - 15.22)	1.08	(0.26 - 4.40)*	0.70	(0.40 - 1.22)*	0.14	(0.03 - 0.64)*	0.66	(0.38 - 1.13)*
Not Ejected	6.45	(2.05 - 20.26)	3.06	(0.63 - 14.83)	6.29	(2.11 - 18.79)	4.02	(2.41 - 6.71)	4.01	(2.02 - 7.95)	3.94	(2.45 - 6.33)
Fatal	0.59	(0.17 - 2.01)*	0.27	(0.01 - 4.86)	0.57	(0.16 - 1.99)*	0.83	(0.64 - 1.09)*	0.23	(0.12 - 0.47)*	0.69	(0.54 - 0.90)*
Not Fatal	7.49	(2.41 - 23.23)	4.01	(0.82 - 19.59)	7.34	(2.47 - 21.81)	5.42	(3.43 - 8.57)	6.53	(2.29 - 18.58)	5.50	(3.55 - 8.52)

* Significant difference ($p<0.05$) between the relative risks of the two subgroups (e.g., fatal vs not fatal)
- There were no instances of females in rollovers with spinal cord injury.

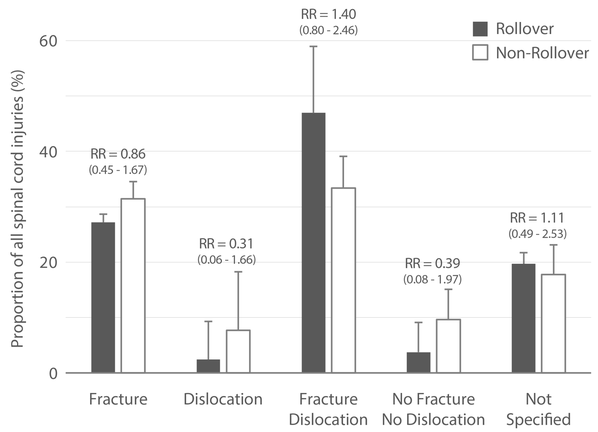


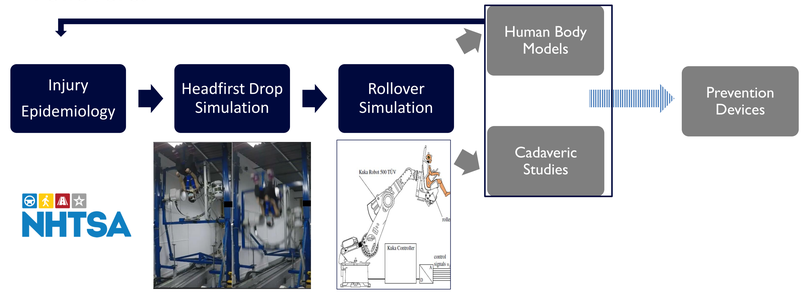
Figure 1. NASS-CDS proportions, standard errors, relative risks (RR), and 95th percentile confidence intervals for RR for all cervical spinal cord injuries (All-CI group) in rollovers (dark bars) and non-rollovers (white bars) stratified by the associated vertebral injury mechanisms (x-axis). All relative risks were not significantly different from one.

Table 2. Comparison of rollover proportions and relative risks between rollovers and non-rollovers in NASS-CDS (2010-2015, model years ≥ 2002 and model years ≥ 1985) and a newer vehicle fleet in CISS (model years ≥ 2010). Also shown are the 95th percentile confidence intervals (CI) for the weighted data/relative risks.

	VI		CI		All-Injuries	
	Rollover proportion (95% CI)	Relative Risk (95% CI)	Rollover proportion (95% CI)	Relative Risk (95% CI)	Rollover proportion (95% CI)	Relative Risk (95% CI)
NASS 1985	28.80% (20.1 - 37.4)	5.16 (3.44 - 7.74)	22.70% (10.2 - 35.2)	3.75 (1.82 - 7.74)	28.10% (20.4 - 35.9)	5.00 (3.46 - 7.23)
NASS 2002	21.20% (11.8 - 30.6)	2.81 (1.48 - 5.34)	10.81% (2.89 - 18.72)	1.26 (0.48 - 3.35)	20.30% (12.7 - 27.9)	2.66 (1.55 - 4.57)
CISS 2010	27.45% (7.07 - 47.84)	6.55 (2.18 - 19.71)	14.94% (0.00 - 31.71)	3.04 (0.64 - 14.41)	26.87% (7.48 - 46.26)	6.36(2.21 -18.33)

CONTRIBUTIONS AND FUTURE DIRECTION

Epidemiology focuses experimental research aiming at better understanding the underlying injury mechanisms and eventually preventing cervical spine injuries in vehicle rollovers.



We designed a novel experiment in which we simulate the yaw, trip and first half roll of automotive rollovers with human subjects to better understand the neck posture and muscle activation prior to headfirst impacts that generate injuries seen in the epidemiology.

REFERENCES

1. Al-Salehi et al., Injury Epidemiology, 2024 (in press)
2. NHTSA. (2014). (DOT HS 812 031)
3. Parenteau et al., Traffic Inj. Prev, 2014
4. University of Duisburg-Essen, 2016

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